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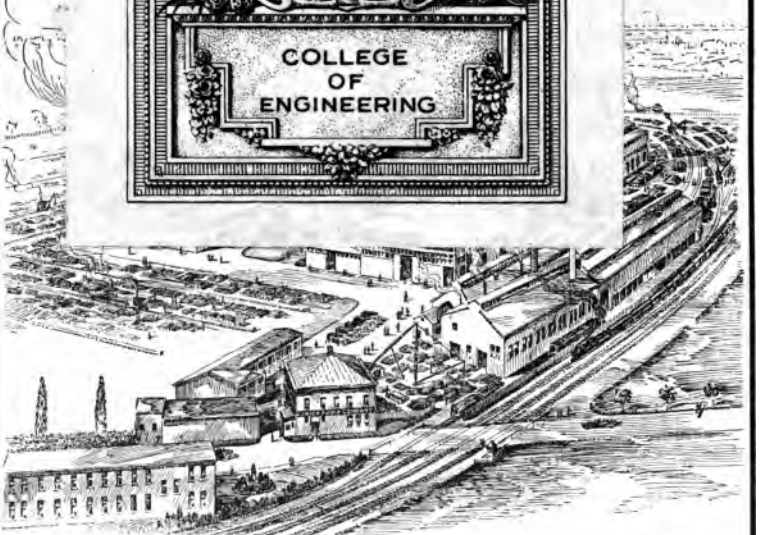

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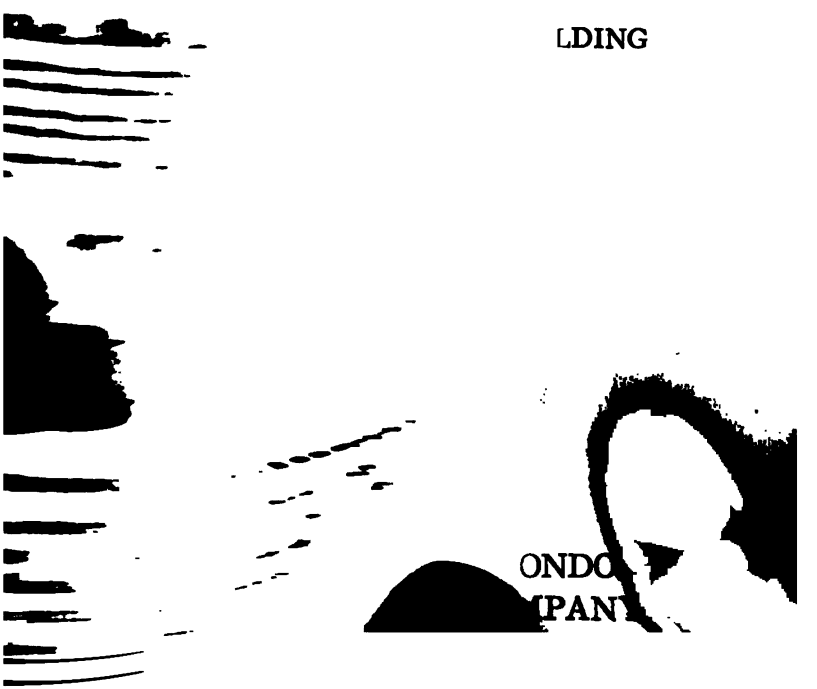

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# FOREWORD

OUR Government needs ships, and from every walk of life men come to the shipyards and endeavor, to the best of their ability, to aid the comparatively few experienced shipbuilders. These new men are handicapped not alone by the fact that they must deal with new standards, new ideas, new materials and new methods, but that the very language employed is foreign to them. Matters are further complicated because many of the skilled ship workers with whom they come in contact have gained their experience in shipyards of various European countries and fail to agree about many things.

A majority of the few books available have been written abroad and deal, for the most part, with the standards and practices native to the authors and of the period previous to the present emergency. We have made a most commendable effort in this country to standardize shipbuilding. Those of us who struggle with the problems of getting the work done will surely welcome any effort that tends to relieve the present confusion of tongues, that is, to standardize terms.

In this edition of "Modern Shipbuilding Terms Defined and Illustrated" an attempt is made to explain the more common words and phrases used in building a steel ship at the present time. The illustrations in nearly every case are taken from ships just built or now building, and the arrangement is such that, if studied in order, they will convey a fair idea of the modern system of shipbuilding.

The first eighteen pictures illustrate the work of "regular shipbuilders" in one of our best "old yards." The next fifteen pictures illustrate the modern miracle, "a fabricated ship" being "assembled" at one of our biggest and best "new yards." The pictures of tools, machines and installations have been selected for the purpose, first, of making clear certain definitions, and, second, of giving an idea of general practice. Each definition has been written with the aim of being intelligible to one without a

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technical education. Whenever possible, in addition to the definitions, a reference is made to a plate wherein the object may be seen in its relations to other parts of the ship. In the appendix important subjects have been treated more fully than could be done in the body of the text. The practice of keeping this book at hand and using it whenever occasion arises should enable one to speak and write accurately concerning the numerous parts of a ship and its equipment, and thus to avoid errors that are detrimental to the individual and injurious to our Cause.

The earnest desire of the author is to help those who strive to build "the bridge of ships." Corrections, questions and suggestions will be gratefully received.

Credit and appreciation is herewith given for the generous aid of the following: The United States Shipping Board, The Massachusetts Institute of Technology, The New York Shipbuilding Corporation, The Bethlehem Shipbuilding Corporation, The Submarine Boat Corporation, The W. & A. Fletcher Company, The General Electric Company, The Westinghouse Electric Company, The Manitowoc Shipbuilding Company, and *The Marine Engineering Journal.*

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F. FORREST PEASE.

AUGUST, 1918.

# MODERN SHIPBUILDING TERMS

## DEFINED AND ILLUSTRATED

**Abaft.** Behind; towards the stern of a vessel.

**Abandon.** To leave a ship when not seaworthy.

**Abeam.** An object is said to be abeam of a vessel when seen nearly at right angles to the side and in a horizontal plane.

**Aboard.** On board; in the ship.

**Aboveboard.** Above deck.

**Abreast.** Opposite to; against.

**Access hole.** A hole through casing, bulkhead or deck to enable one to reach work or gear. See Plate IX.

**Accommodation ladder.** A light temporary ladder hung over the ship's side at the gangway.

**Acetylene.** See Appendix.

**Adrift.** Afloat or unfastened, as a boat or a spar; a ship which has parted from her anchor.

**Adze.** A steel instrument with an arching blade across the line of the handle, and ground from a base on its inside to the outer edge; used for chipping a horizontal surface of timber.

**Aft.** Toward the stern.

**After body.** That portion of the hull between amidships and stern.

**After hatchway.** The hatchway nearest the stern.

**After peak.** A compartment in the extreme stern.

**After-peak bulkhead.** The bulkhead at the stern next to the after peak; always watertight. See Plate XXIV.

**After perpendicular.** A vertical straight line at the after edge of a rudder post.

**Aground.** Resting on the ground. A vessel resting on the shore or bottom so as to be unable to move is said to be aground.

**Ahead.** In front of, before; to propel the ship forward.

**Ahead and astern eccentric rods.** Rods controlling valve motion of engine.

**Air cock.** A cock fitted to a pump, hot-well, condenser, etc., to prevent the entry or escape of air; on boiler, to run off all air before steaming.

**Air course.** A space from 4″ to 6″ wide in the ceiling or between the beam ends of a vessel for the admission of air.

**Air-course bars.** Shutters to close the air courses when desired.

**Air hammer.** A hammer driven by compressed air for riveting. Sometimes called an air gun or "gun."

**Air holding-on hammer.** A hammer with air cushion for holding against a rivet. See Plate LV.

**Air pipes.** Pipes leading from the tank or double bottom to the upper side of the main deck for the purpose of letting air into the tanks, when the water ballast is being pumped out.

**Air port.** An opening in the vessel's side or deck house for ventilation.

**Air pump.** A machine for exhausting the air from a condenser. When a reciprocating engine is used it is generally driven directly by means of a lever. With turbines, an auxiliary engine, turbine, or motor is used.

**Air pump bucket packing.** The packing around the bucket or piston making tight contact with walls of air cylinder.

**Air valve.** A valve controlling air for forced draft to boilers (operated by a lever on front of boiler). See Plate XXXVIII.

**Alarm valve.** A small safety valve to give alarm in case main safety valve should prove defective.

**Aloft.** Up in the tops; overhead; in the upper rigging or on the yards, etc.

**Alow.** Low down, below; or below deck.

**Amidships.** Generally speaking, the middle portion of a vessel.

**Anchor.** An iron instrument for holding a ship or other vessel at rest in the water.

**Anchor deck** (old term). The monkey forecastle, principally used for the storage of the bowers. See Forecastle.

**Angle.** The point where two lines meet. Sometimes used as a shorter term for angle iron.

**Angle bars.** Bars of iron with cross-section the shape of a right angle.

**Angle iron.** See Angle bars.

**Angle clip.** A piece of angle iron used to fasten one part of a ship's structure to another. See Plates XIX and LXII.

**Angle collar.** A fitting made of angle iron, and used to make watertight a deck, bulkhead, etc., where it is pierced by some structural shape.

**Angle knee.** See Staples; also, see Plate LX.

**Angle staples.** See Staples, also Plates LX and LXI.

**Anneal.** To render iron or other metals less brittle, by heating and cooling slowly.

**Apeak.** An anchor is apeak when the cable is as nearly vertical as is possible without lifting the anchor from the bottom.

**Apron plate.** A small plate on forecastle deck to cover stem, sometimes used to support a chock. See Plate XXX.

**Apron,** stemson, or stomach-piece (wooden ship term). A

backing or strengthening timber behind the stem-post of a vessel.

**Arching.** See Hogging.

**Arch piece** (of stern frame). The curved portion of the sternpost above the screw aperture or well. See Plate XXVII.

**Ardency.** The tendency a ship has to fly up to the wind, thus showing that the position of her center of effort is abaft the center of lateral resistance.

**Ash cocks.** Cocks serving to supply water to cool hot ashes; sometimes called fireman's cocks.

**Ash ejector.** An ejector for discharging ashes overboard.

**Ash hoist.** The gear, consisting of a winch, bucket, etc., by which ashes are hoisted from the fire room.

**Ash pit.** The space below the fire grate of the furnace.

**Ash shute.** A movable iron shute by which ashes are passed overboard.

**Ashore.** On terra firma, aground.

**Assemble.** To collect or put into place different parts.

**Astern.** Just beyond the stern, looking aft. Opposite of going ahead.

**Athwart, athwartships.** Across, from side to side. Hence the rowers' seats in an open boat are called "thwarts" because they are athwart, or across the boat; transverse.

**Auxiliaries.** A term applied to machines aboard ship other than the propelling machinery.

**Auxiliary foundations.** The supports for pumps, condensers, distillers, etc.

**Auxiliary steam pipe.** A pipe attached to a steam dome for leading steam to auxiliary engines.

**Awning deck.** See Deck.

**Babbitt metal.** A metal used for bearings; generally composed 10 parts tin, 1 copper, 1 antimony.

**Back-board.** A support for the back of a person steering a boat.

**Backing.** Making a vessel go backwards or astern.

**Backing angle.** A piece of angle iron for reinforcing at the butt point or splice of two angle irons, put on back side.

**Backstays.** Ropes stretched from a mast or topmast head to the sides of a vessel, slightly aft of the mast, to give extra support to the mast to keep it from going forward.

**Baffle plates.** Plates fitted in a surface condenser opposite the steam entrance, for the purpose of distributing the steam equally over the tubes. Used in boilers to keep water from entering the steam pipe.

**Balance cylinder.** A small cylinder enclosing a valve balance piston. See Plate XXXIV.

**Balance piston.** A small piston enclosed in a cylinder on the top of a steam chest to assist the lifting of a slide valve. See Plate XXXIV.

**Balanced rudder.** A rudder so hung that part of the rudder blade extends forward of the rudder post (a design used on fast vessels to relieve the strain from the steering gear).

**Ball weights** (on governors). Ball-shaped weights that by virtue of centrifugal force tend to move and so operate governor valve. See Plate XLI.

**Ballast.** Anything used solely to load the ship, for stability or submerging purposes.

**Ballast port.** A small square aperture in a vessel's side, for taking in or discharging of ballast.

**Ballast pump.** A pump for handling ballast water to take care of weather conditions at sea.

**Ballast tanks.** Tanks for ballast, usually filled with fresh water. As this fresh water is withdrawn for use, salt water can take its place in the tank.

**Banjo frame.** An apparatus for lifting or lowering the propeller of an "auxiliary screw steamer" from the "screw well," as required.

**Bank.** An elevated part of the bottom of the sea, sometimes dangerous to navigation.

**Bar iron.** Iron wrought into malleable bars of various cross-sections.

**Bar keel.** A vertical keel extending below bottom line of the hull, made of a heavy rectangular bar. The garboard plates knuckle or bend down and are riveted to the bar keel.

**Bar stringer.** Two angle bars fitted back to back, placed at the inside of the frames in any part of the vessel above the floors.

**Barge.** A general name given to vessels built to be towed.

**Bark.** A three-masted vessel, square rigged on the fore and main masts, and fore-and-aft rigged on the mizzen.

**Barkentine.** A three-masted vessel, square rigged on the foremast, and fore and aft on the main and mizzen.

**Barnacles.** A general term among seafaring men for any of those shelled animals of the division mollusca, which fix themselves to the bottom of boats, the piles of quays, piers, etc., under water, and more especially at the water line, or between high and low water marks.

**Barrel, capstan.** That part of the capstan which turns, and around which the rope is wound for hauling purposes.

**Baseplate, bedplate.** A heavy casting of metal, forming a bed or foundation of a machine of any kind. See Plate XXXV.

**Basin.** A dock in which vessels float at any stage of the tide.

**Bat rivet.** A rivet with a cone head.

**Batten.** A slender strip of wood used to establish lines.

**Batten bar.** A bar of iron used to fasten down a tarpaulin over a hatch.

**Battens, cargo.** Strips of iron or wood placed on the frames of a ship to keep the cargo clear.

**Battened down.** To make watertight the tarpaulin covering over hatches by means of battens, wedges and cleats, securely fastened to the hatchway coamings.

**Beak, beakhead.** The beak is the extreme forepart of a vessel. The beakhead is the small platform between the figure-head and the bulwarks of the forecastle.

**Beam.** The greatest width of a vessel.

**Beams.** The members of a ship's frame that span a vessel from side to side. (Half beams extend from side of hatch to side of ship.) The molding of a beam is its size up and down. The siding of a beam is its measurement fore and aft. Beams are given the name of the deck in which they are placed; as, bridge deck beams, main deck beams, poop deck beams, shelter deck beams, etc. See Plate XII.

**Beam angle bar.** Any angle bar used in the construction of the beam.

**Beam brackets.** Triangular steel plates used to fasten steel beams in a steel ship to the side frames. See Plate XXVI.

**Beam carlings.** Short pieces of timber, bulb-plates, etc., fitted diagonally or longitudinally between the deck beams to stiffen them.

**Beam engine.** An engine having a pivoted beam connected between piston rod and connecting rod. (In general use on side-wheel steamers.)

**Beam grabs.** Iron claws gripping an overhead beam in the engine room for lifting shafts, cylinder covers and other parts of machinery.

**Beam knees.** Blocks of wood used to fasten the beams to the framework (in wooden ship). End of steel beams turned down and connected to top of side frames.

**Bearding.** The knuckle line of plating at the stem and sternpost.

**Bearding angle.** An angle connecting stem to shell plating.

**Bearers.** The vertical plates that take the load in a foundation or stool.

**Bearing blocks.** The bottom half of main bearings.

**Bearing bolts.** Bolts by which the brasses, caps and keepers of a bearing are held in place.

**Bearing keeper.** A keep or cap covering a shaft bearing of any kind.

**Beckets.** Small eyes fastened at the breach end of blocks to take the thimble on the standing part of a tackle. They are useful to have on all spare tackle blocks.

**Bed.** That portion of the extreme fore end of a vessel on which the middle part of a bowsprit is lodged or bedded; also, that part of the bowsprit in the bed.

**Bedplate.** A plate forming the base of an engine, winch or other piece of machinery. See Baseplate.

**Bees** (of a bowsprit). Battens of wood or iron attached one each side to a bowsprit, each having a hole near the bowsprit-cap, through which the fore-topmast stays are rove to form their support.

**Before.** Forward, in front of; more often expressed afore.

**Belay.** To make fast a rope by twisting it round (in the manner of a figure 8) a cleat, kevel, or belaying-pin, without tying it into a knot.

**Belaying-pins.** Wooden or metal pins inserted in holes perforated in rails, etc., on which running rigging is belayed.

**Bells.** On shipboard bells express the time, and are struck every half hour, as follows: 12 o'clock noon, 8 bells; 12.30, 1 bell; 1 o'clock, 2 bells; 1.30 o'clock, 3 bells; 2 o'clock, 4 bells; 2:30, 5 bells; 3 o'clock, 6 bells; 3:30, 7 bells; 4 o'clock, 8 bells, and repeat to 8 o'clock, 8 o'clock to midnight—and so on. (When anchored in a fog, a ship's bell is used to warn others of her position.)

**Bell crank.** A piece of metal so shaped as to change direction of pull; often triangular in form.

**Bellyband, girthband.** A narrow band of canvas sewn across the belly of a sail for extra strength.

**Belt gearing.** Gearing for transmission of power by means of wheels connected by a link belt.

**Below.** Low down; below deck; under water.

**Bend.** A general sea term for fastening anything; as, to bend one rope to another, a sail to a yard, the cable to its anchor, etc.

**Bending press.** A hydraulic press for bending steel forms.

**Bending rolls.** A large machine used to give curvature to plates by passing them between heavy iron rolls. See Plate XLVI.

**Bending slab or block.** In a steel mill, in front of the furnace, a large section of the floor is covered with cast-iron blocks placed securely in position. These blocks contain holes arranged checker-board wise. Pins are driven in these holes to clamp down steel shapes that are being bent. Smaller bending slabs are used by the anglesmith and in the blacksmith shop. See Plate XXXI.

**Bends or wales.** A general term for the thick outside planking of a vessel, about midway between the plank sheer and the light water line. The breadth of the wales is generally equal to one-fourth or one-third of the vessel's depth, and the thickness from 3 to 9 inches, according to the size of the vessel.

**Berth.** A bunk or bed; an apartment in a vessel where officers or men live together. Berth is also used to note position; as, "He has a berth as first officer."

It is often used to describe where a ship is tied up or stationed; as, "She is at her berth on the North River."

**Between decks.** The space between the upper and lower decks.

**Bevel.** The angle at which a flange is bent or a cut made.

**Bevel (v.).** To change the angle of a shape to make it fit in a certain place.

**Bevel-faced hammer.** A riveting hammer with sloping face.

**Bevel-faced holding-on hammer.** A heavy hammer with sloping face for holding against a rivet.

**Bevel pinion, bevel wheel.** A wheel the teeth of which form an angle with the shaft and fitting into the teeth of a similar wheel. The smaller one is called the pinion, the larger one, the gear.

**Bibbs.** Brackets or bolsters near the head of a mast upon which rest the trestle trees. Bibbs are also called hounds.

**Bight (of a rope).** The double part when it is folded; the bend or loop in a rope as distinct from the ends.

**Bilge.** The rounded surface of a vessel forming the transition from the flat bottom to the upward rising sides. See Plate II.

**Bilge blocks.** A group of supporting blocks under the bilge during construction. See Plate V.

**Bilge discharge pipe.** A pipe leading from a bilge pump to a bilge discharge valve on the ship's side, for conveying the water overboard.

**Bilge ejector.** An apparatus to force out bilge water, i.e., the water accumulated between the floors.

**Bilge injection.** An arrangement through which (in cases of emergency) bilge water is taken into condensers' circulating system; in this way the circulating pump helps to free the ship of water.

**Bilge injection water.** Water taken by the circulating pump from the bilge.

**Bilge inlet.** An aperture in the bottom plating of a vessel in communication with a valve or cock fitted on the inside against such plating, for the admission of sea water when required to fill a water-ballast tank, a steam boiler, etc.

**Bilge intercostal keelson.** A line of plates fitted in the lower turn of the bilge between the frames or floors.

**Bilge intercostal keelson angle bars.** Short angle bars by which bilge intercostal plates are attached to the outside plating; in some instances also to the floors.

**Bilge intercostal plates.** Plates forming a bilge intercostal keelson.

**Bilge intercostal stringer.** An intercostal stringer fitted at the upper turn of the bilge, connected with a bilge stringer upon the frames.

**Bilge keel.** A keel usually composed of angle bars, fixed back to back, having a bulb plate between them, fitted on the outside of each bilge, extending about three-fifths of the vessel's length. Its purpose is to keep a vessel steady and reduce the rolling. Sometimes called docking keel.

**Bilge keel angle bar.** An angle bar used in the construction of a bilge keel.

**Bilge keelson.** A girder placed at the lower turn of the bilge, generally composed of double angle bars fixed back to back, with plate between.

**Bilge plate.** A strake of plating fitted upon the frames under the bilge planking of a wooden ship; any plate in a bilge strake of iron or steel vessels.

**Bilge plating.** The bottom plating covering the outside of the frames in the bilge of a vessel. See Plate III.

**Bilge pump.** A pump to draw the bilge water from a ship.

**Bilge shores.** Short, stout pieces of timber, placed under the bilges of vessels, when in dry-dock, on a slipway, etc., for support. See Plate IV.

**Bilge strake.** A strake in the bilge (outside or inside) of a vessel.

**Bilge stringer.** Double angle bars or any other form of stringer fitted in the upper turn of the bilge.

**Bilge stringer angle bar.** An angle bar forming part of a bilge stringer.

**Bilge suction.** The arrangement consisting of pipes, etc., in connection with a bilge or a circulating pump, by means of which water accumulated in a vessel is raised.

**Bilge water.** The water accumulated between the floors in a ship.

**Bilgeways.** The timbers upon which a vessel is launched.

**Bill** (of an anchor). The extremity of the fluke.

**Billboard.** A support upon which the bills, or flukes, of the anchor rest when it is on deck.

**Billboard.** The planking, plating, etc., fitted on the outside of a bulwark abaft the cathead as a protection against abrasion by the bill or pea of an anchor, while being taken inboard from under the cathead, by means of the fish tackle.

**Bind.** To wind around, as binding the end of a rope with yarn. Also, an iron band, as the binding of a deadeye.

**Binding strake.** A strake of deck planking, etc., having greater thickness or strength than neighboring strakes.

**Binnacle.** A stand or case for a ship's compass, placed usually beside the steering wheel.

**Bite.** Spoken of an anchor when it holds the ground; it then bites.

**Bitts.** Timbers extending vertically above a ship's deck; for instance, round the masts. Also, iron heads fixed on any deck, forecastle, bridge, or raised quarter-deck for belaying of hawsers, warps, ropes, etc.

**Bitumastic.** An elastic cement used in place of paint to protect the steel.

**Black strake.** The strake of planking next above the wales.

**Blades, screw.** The arms of a propeller.

**Blast cock.** A cock connected to the blast pipe.

**Bleeder plug.** A drain plug in ship's bottom to be used when in drydock.

**Blind pulley.** A block without a sheave in it.

**Block.** A device to hold one or more sheaves over which rope, chain, or wire cable is run.

**Blocks, keel.** See Keel.

**Block stopper.** A short piece of rope with a hook at one end which may be put through the eye of a block. It is used to hold (or "stop off") a line upon which there is a strain, while it is being taken from the winch and made fast in its proper place.

**Block and tackle.** Two blocks with rope in place ready for hauling purposes.

**Blowcock, blow-out cock, blow-off cock, blow-down cock.** A cock in the blow-off pipe.

**Blow-down pipe.** A pipe through which the water is discharged when the boilers are blown off.

**Blow-through pipe.** A pipe through which the steam enters the condenser, to expel the air from it previous to starting the engine.

**Blow-off valve, blow-through valve** (as above). See Blow-off cock.

**Boat chocks.** Frames fitted upon an upper deck, bridge or poop deck, etc., conforming to the shape of the bottom of the boat which is bedded in it.

**Boat chock standards.** Short iron pillars fitted underneath boat-chocks to raise the supported boat higher above the decks, to lessen the danger to a boat from any sea breaking on board.

**Boat gear.** All the appurtenances in connection with a boat.

**Boat grips.** Flat iron hooks fitted with lashings, or with screwing-gear to be connected to eye-bolts in a deck, and serving to hold a boat in the chocks.

**Boat's painter.** A rope or chain which keeps a boat from drifting away, when afloat alongside a vessel, quay, etc.

**Boat skids.** Beams supported by stanchions above the bulwark for boats, spars, etc., to be stowed on.

**Boat skids stanchions.** The stanchions by which the boat skids are supported.

**Boat tackles.** Tackles in connection with boat davits, to hoist boats out of or lower them into the water.

**Boat tanks.** Airtight metal cases, fitted inside a lifeboat, to give increased buoyancy and prevent its sinking if filled with water.

**Boat thwarts.** The flat boards fitted athwartships, forming seats for the rowers.

**Boat tiller.** The piece of wood, or metal bar, in the rudder head, by which it is turned and the boat steered.

**Boatswain.** An officer on board of a ship who has charge of the boats, sails, rigging, colors, anchors, cables, and cordage. His office is also to summon the crew to their duty, to relieve the watch, assist in the necessary business of the ship, seize and punish offenders, etc.

**Bobstays.** Stays extending from the outer end of a bowsprit (inclining downward) to a vessel's stem, to keep the bowsprit down in its bed.

**Body plan.** The end view of a ship showing the curves of the sides at any point in her length.

**Body post.** The propeller post.

**Boiler back end plate.** The plate at the opposite end of the boiler to that at which it is fired.

**Boiler brackets.** Brackets riveted to boiler shell to afford a means of holding boiler in position.

**Boiler casing.** A casing of iron or steel, enclosing a boiler room and hatchway. See Plate XIV.

**Boiler chocks.** Vertical steel plates fitted at each end to keep a boiler from sliding ahead or astern.

**Boiler head.** The end of a boiler, flanged to the sides.

**Boiler hatchway, boiler opening.** The aperture in a steamer's deck through which boilers are taken in or lifted out.

**Boiler lagging.** A covering to retain heat fitted over the upper half of a boiler, usually asbestos or magnesium.

**Boiler saddles.** Iron forms provided to receive boilers and support them.

**Boiler seating.** The stools, etc., upon which a boiler is bedded.

**Boiler shell.** The plates forming the body of a boiler exclusive of the end plates.

**Boiler space, boiler room.** The place where the boilers in a steamer are bedded.

**Boiler stays.** Rods through boiler from front to back to hold heads in place.

**Boiler tubes, fire tubes.** Tubes inserted in the body of a boiler, extending nearly its entire length, through which the smoke and gases from the combustion chamber pass for the purposes of increasing the heating surface.

**Bollards.** An old name, though still in use, for those posts of timber frequently seen on the sides of docks, quays, piers, etc., on which hawsers or springs (ropes) are thrown for hauling vessels alongside.

**Bolster.** A pad or piece of timber used to "bolster up" any-

thing requiring slight alteration or support.

**Bolt.** A short rod of iron or other metal with a head on one end and the other end threaded.

**Bolter up.** One who bolts up.

**Bolting up.** Forcing plates and shapes into place by means of bolts and nuts. See Plate XXIII.

**Booby hatch.** The scuttle in a ship's deck, covered by a hood or companion, giving entrance to atween-decks.

**Boom.** The lower spar for a fore-and-aft sail.

**Boom, boat.** A pole extending outboard (i.e., outwards from a vessel) to keep boats clear of ship's side.

**Boom, cargo.** A boom extending from the mast like a derrick arm to handle cargo. See Plate XVIII.

**Boom crutch.** The crutch for the reception of a boom when the boom is not in use.

**Boom guy, back rope.** A rope attached to the end of a boom and fastened to a rail, belaying-pin, etc., somewhere on the vessel's side, to prevent the boom swinging over when sailing before the wind, or to keep it steady during calm, light, or changeable winds.

**Boom mountings.** The iron "gear" that fastens a boom to the mast; all iron bands on a boom.

**Boomkin, bumpkin, bumkin.** A short piece of timber or strong iron bar extending over the bow or from the quarters of a vessel.

**Boot-topping.** The outside plating of iron and steel vessels between the light water line and the load line, on which part paint of a different color from that used for the bottom of the vessel and the topsides is often put. The paint or coating is also called boot-topping.

**Bosom piece.** An angle bar (butt strap) fitted in the throat of two other angle bars to connect them. See Plate LX.

**Boss.** Any protuberance on parts; as the projecting portion of a propeller post. See Plate XXVII.

**Boss barrel.** A name applied to the section of plating adjacent to the stern tube.

**Boss frame.** A frame bent to allow room for the stern tube, or tail shafts in the case of twin-screw ships.

**Boss of a propeller post, boss of a sternpost.** The enlarged part of propeller post, for passage of shaft.

**Boss plate.** A curved plate covering (one on each side) the boss of a propeller post and the curved portion of frames in way of the stern tube of a screw steamer. It is generally thicker than the other plates in the same strake (before furnacing).

**Bossing around shafts.** The projecting portion of a propeller post encircling the shaft hole.

**Bottom.** That part of the ship which is under the water line.

**Bottom of a ship.** The lower portion of a vessel; from the keel to the height of the water line.

**Bottom longitudinals.** Fore-and-aft members of bottom frame.

**Bottom planks.** All the planks on the outside of the frames between the garboard and the wales are called "bottom-planks," and have usually a thickness from 2 to 8 inches, according to the size of the ship.

**Bottom plate.** Any plate forming part of the bottom plating of a vessel.

**Bottom strake.** Any strake of plating between the garboard and the light water line of the vessel.

**Bottomry.** A term in commercial law referring to the letting or mortgaging of ships.

**Bound.** Tightly held.

**Outward bound.** Leaving home.

**Homeward bound.** Returning home.

**Tide bound.** Unable to make progress because of a head tide.

**Wind bound.** At anchor because unable to make progress in consequence of contrary winds.

**Bounding bar.** An angle which surrounds a plate in a frame, or a bulkhead, to make watertight connections. See Plate XXII.

**Bow.** The sides at the forepart of a vessel, distinguished one from the other by the right and left hand, the first being the starboard bow and the second the port bow.

**Bow anchors, bower anchors.** The heaviest anchors on board a vessel. They are lowered from the bow, hence their name, and serve principally for anchoring a ship in a river, bay, etc.

**Bow chock.** A chock fitted on a forecastle deck, or to bow chock plate.

**Bow chock plate.** A plate fitted (one each side) on the upper portion of a stem above the forecastle deck, or above the upper deck, to take bow chock.

**Bow grace.** Fenders hung over a vessel's bow to prevent damage by ice.

**Bow of a rudder.** Arched piece of metal forming the backpiece and extending from the upper to the heel pintle.

**Bow plate.** Any of the shell plates in the bow of a ship.

**Bow plating.** Plates covering the outside of the frames in the bow of a vessel.

**Bow rope.** A rope passed over the bow of a vessel, one end kept on board, the other used to haul her to the quay, etc., or to another vessel. One passed over the stern is called the stern rope, and is used for similar purposes aft.

**Bowsprit.** One of the main spars in a vessel. It is a pole or "sprit" projecting forward from the stem and taking the forestays and the bobstays.

**Bower.** One of the large anchors of a ship which hold her by the bows, hence the name.

**Bowlines.** Ropes by which a square foresail, mainsail, crossjack, etc., is stretched forward, when a vessel is sailing close by the wind.

**Bow port.** A small aperture in the bow of a vessel, serving for loading and discharging of timber, rails, etc.

**Box coupling.** A strong cylindrical forging, into which the ends of two lengths of shafting are inserted, and by which they are kept together and in line.

**Brace.** A rope communicating with a boom or yardarm for the purpose of trimming the sail to which such a spar may be attached.

**Braces.** Braces are formed at the ends of supporting arms which are turned out to take fitted pintles. The eyes in which a rudder swings are sometimes called braces.

**Brackets.** Angular-shaped pieces of iron or steel plate, fitted vertically as a support. Brackets are employed to connect the ends of beams to frames, and are used in the construction of double bottoms, etc. See Plates XXIV and XXVI.

**Braze.** To join by using hard solder.

**Breadth** (extreme). The greatest breadth, including the thickness of the outside planking or plating.

**Breakers.** Waves broken by contact with the side, bow, or stern of a vessel; or a shoal, rock, bar, etc., not lying deeply under water.

**Break in.** To bend in a sheet back of a seam by too heavy caulking.

**Breast hooks.** Triangular pieces connecting stringers to stem or stern.

**Bridge.** A decked structure from 6 to 8 feet in height, generally fitted about amidships, and extending from side to side over the upper deck of a vessel. See Plate XVIII.

**Bridge house.** A house built convenient to bridge (see Pilot house). See Plate XVIII.

**Long bridge.** On tankers, a narrow walk connecting forward deck house to after deck house. On large passenger ships, a bridge having considerable length fore and aft.

**Bridge plate.** A plate at back end of firebox to support grates.

**Brig.** A vessel with two masts (fore and main), both of them square rigged, but having a gaff mainsail.

**Brigantine.** A vessel with two masts (fore and main), the foremast square rigged and the mainmast schooner rigged. The rig, however, may vary slightly.

**Broach.** To slew around when running before the wind.

**Broken backed.** A vessel is said to be broken backed when through accident, weakness, or

age she has lost her original sheer, and appears to be humpbacked.

**Brow.** A small inclined runway to allow passageway of trucks through bulkhead doors, etc., or half-round molding on coamings to protect ropes when drawn over same.

**Bucklers.** Pieces of wood plugging the hawse holes temporarily.

**Built columns.** Columns made by riveting together plates and channel iron or other shapes.

**Bulb angle bar.** An angle bar having a bulb on one flange. See Plate LIX.

**Bulb angle beam.** A beam formed of a bulb angle bar.

**Bulb plate.** A narrow plate having a bulb or swell on one of its edges, employed in the construction of beams, bilge keels, etc.

**Bulb tee.** Tee iron with a bulb on the base. See Plate LIX.

**Bulgeways or bilgeways.** Timbers placed beneath a vessel while building.

**Bulk cargo.** Loose material, as coal, grain, etc.

**Bulkhead.** A partition of almost any material, as wood, canvas or iron. Sometimes its office is to render a vessel more secure by dividing it into watertight compartments. See Plate XXV.

**Bulkhead center line.** A center line on bulkhead for reference purposes.

**Bulkhead, center line.** A bulkhead built fore and aft on center line of ship. See Plate VII.

**Bulkhead, forepeak.** The bulkhead farthest forward, generally called collision bulkhead. See Plate XXV.

**Bulkhead sluice.** A small opening in a watertight bulkhead, which can be opened or closed from the deck.

**Bulkhead stiffeners.** Channel or angle irons fastened to a bulkhead at frequent intervals for reinforcement.

**Bull's eye.** A round window in a cabin. Sometimes the central part of a porthole light

**Bull ring.** A ring to hold piston rings in position.

**Bull riveting.** Pressing rivets into place with an air or hydraulic machine.

**Bulwarks.** Plating or planking on the side of a ship, extending up from deck to rail. See Plate LXII.

**Bunk.** A fixed bed on board ship.

**Bunkers.** The place where the coal for consumption on board of a steamer is stowed.

**Buntlines.** Ropes which are used to haul the middle part of a square sail up to the yardarms.

**Buoy.** A floating object moored over a certain spot.

**Buoyancy.** The capacity for floating which a vessel possesses.

**Burden.** The carrying capacity of a vessel; as, 100 tons burden.

**Burton.** A light hoisting tackle, usually one kept hooked to the

pendant at the topmast head. It is composed of two single blocks which the tackle receives. This has the same power as the luff tackle, but less friction.

**Bushing.** A short tube inserted as a lining in another tube or bearing for a shaft, rod, or part to work in.

**Butt.** The flat end of a plate, angle, bulb, or plank.

**Butt joint.** A joint formed by "butting" the edges of plates together.

**Butt plates.** The term given to plates connecting the ends of the outside planking, in a composite vessel.

**Butt seams** The joints between the butts of plating or planking.

**Butt strap.** A piece of plate used to strengthen a butt joint.

**Butt strip.** A strip of plate having at least the thickness of plates it connects, and in many instances it is 1-16 and even ⅛ of an inch thicker than the plates.

**Buttock.** The rounded convex portion of the lower stern of a vessel (or the transom); which forms the transition from the stern to the flat side of the vessel.

**Buttock line.** See Lines.

**Buttock plate.** Any plate in the buttock of a vessel.

**Cabin.** An apartment on shipboard for use of officers and passengers.

**Cable.** The rope or chain by which a ship's anchor is held.

**Cable clench bracket.** A reinforced bracket in each chain locker for securing end of cable.

**Cable-laid rope.** A rope made by laying three hawser-laid ropes from right to left.

**Cable length.** A term used in roughly estimating short distances between objects; as, one or two or three cable lengths apart. (About one-tenth of a nautical mile, 600 ft.)

**Cable lifter.** The drum on a windlass so designed as to grip the links in the mooring cable.

**Cable molding.** A molding carved in the form of a rope, frequently used as a decoration for a vessel's stern.

**Caisson.** A kind of floating dock which may be sunk under a vessel's keel, where she is moored, and used to lift her.

**Camber.** The curve or round of a deck, sometimes called the crown.

**Cant.** A piece of wood used to prop up some part of a construction is called a cant.

**Cant body.** The fore or after end of a vessel, where the frames have less girth than in the midship part.

**Cant frame.** Frames in the fore and aft body of a vessel not in line with the square body frame and not at right angles to the keel. See Plate XI.

**Cap.** A ring at the end of a spar; a piece of leather or tarred canvas over the end of a rope to protect it from the weather.

**Capstan.** A long drum revolving in a vertical position, used generally for hauling in heavy lines. It may be connected to a windlass and used to hoist the anchor "by hand."

**Capstan bar.** A bar of wood for turning the capstan.

**Careen.** The slanting position in which a ship may be placed by wind or wave; sometimes done for repairs, when alongside a dock or the shore. Tackles from masts to dock are then used to haul ship over on her side.

**Cargo.** Goods taken on board of vessel for transportation.

**Cargo battens.** Strips of wood or iron fastened at close intervals in longitudinal position to the frames on the inside of the ship to protect the cargo and frames from chafing.

**Cargo boom.** See Boom, cargo.

**Cargo port.** A large opening in a vessel's side through which cargo is passed on and off. See Plate XV.

**Cargo hatch, cargo hatchway.** An opening in a ship's deck for the loading and discharging of any kind of cargo or merchandise. See Plate XIV.

**Carlings or carlines** Short beams running fore and aft between the great transverse beams, which they bind securely together. They also aid in supporting the deck. See Plate XV.

**Carrying dog.** A tool for lifting a plate or shape.

**Casing.** The covering put round or about any part or object needing protection.

**Cat.** A name at one time given to a ship of peculiar build, and used, commonly, in the coal trade.

**Cat davit.** An anchor davit used instead of a cathead.

**Cathead.** A timber projecting from the bow, to which the anchor is secured.

**Cathead stopper.** A chain by which a bower is held, when hanging under the cathead.

**Cat-and-fish tackle, "fish tackle."** A tackle fitted to the anchor davit crane, or masthead for casting the anchor, i.e., hoisting an anchor into its place on deck.

**Cathook.** The hook by which the fish tackle is attached to anchor.

**Cat's paw.** A light air perceived in a calm by a slight rippling of the surface of the water. A peculiar twist or hitch in the bight of a rope made to hook a tackle on.

**Caulker.** One who caulks. See Plate LIII.

**Caulking.** A process of filling the seams of a vessel with oakum, to prevent leaking. In steel ships, to make tight by swaging the edges of the shapes or plates. See Plate LIII.

**Caulking box.** A chest in which caulking tools are kept, serving also as a seat for the caulker.

**Caulking iron.** An iron tool of chisel form, used for driving oakum into the seams.

**Caulking mallet.** A wooden hammer used to strike the caulking iron, when caulking.

**Ceiling.** A covering consisting of planking or boards fastened to the frames, reversed frames, or tank top in a manner such that it can be easily removed. Its purpose is to protect the cargo. (In wooden ships the ceiling forms an inner skin and is structurally a part of the ship.)

**Ceiling hatches.** Lids in the floor-ceiling of a vessel, fitted with rings for lifting them, so that after the discharge of every cargo the limbers can be inspected and cleaned, and the cement in the bottom repaired if required.

**Cellular double bottom.** A double bottom constructed on a cellular pattern. There are two methods; one in which the floors are continuous and the girders intercostal, the other having the girders continuous and the floors intercostal.

**Center bearer of firebars.** A support for the ends of furnace bars at the half-length of a furnace.

**Centerboard, center keel or drop keel.** A heavy, movable plate of iron, lead, or timber let down below the keel of a sailing boat about amidships.

**Center of buoyancy.** The center of gravity of the water displaced by any vessel.

**Center girder.** A girder placed at the center line of a vessel in the construction of a double bottom.

**Center-line bulkhead.** A bulkhead running fore and aft through the center of ship. See Plate VII.

**Center of gravity.** Center of weight.

**Center vertical keel or keelson.** Vertical plates continuous fore and aft, fitted usually watertight and connected, top and bottom, to inner plating and plate keel with suitable angle bars. See Plates III and XIX.

**Central stringer.** A girder composed of angle bars fitted in the center line of a vessel in a fore-and-aft direction, under the deck beams, for the reception of the upper ends of pillars, so as to stiffen the deck beams.

**Chafe.** To rub or wear away by rubbing.

**Chafing plate.** A plate to minimize chafing of ropes, as at hatchways.

**Chain hook.** A long-handled hook, used to drag a chain along a deck or to assist in hauling it up, or in stowing it in the chain locker.

**Chain pipe.** A cast-iron pipe fitted vertically on the upper deck above the chain locker and through which the chain cables are taken out and let into the locker.

**Chain plates.** Flat bars of iron running upward from beneath the channels, and taking the deadeyes by which the shrouds of the masts are held down.

**Chain riveting.** Two or more parallel rows of rivets so placed that they are perpendicular to each other, or directly opposite to each other (not reeled or staggered).

**Chain stopper.** A fitting for holding a chain cable or keeping it from running out too rapidly.

**Chain swivel.** A link in a chain so designed that one part may turn upon the other.

**Chain takerpipe.** An iron pipe or casing in the deck of a ship through which the chain cable is led.

**Chamfer.** To take the edge off or bevel a plank, which is then said to have a chamfered edge. The edges of steel plates, angles, and various steel forms are beveled or chamfered before caulking.

**Channels.** Wooden platforms projecting from the hull on each side; their office is to keep the chains and channel plates away from the sides.

**Channel bars.** Iron forms with cross-section like a squarely shaped letter U. See Plate LIX.

**Channel rail.** A piece of batten or molding fitted in a fore-and-aft direction on the outer edge of a channel.

**Chart house.** A house just aft of the wheelhouse. See Plate XVIII.

**Check bolt.** A bolt fitted to prevent the motion of anything beyond a determined point.

**Check pin.** A short circular pin of iron or steel projecting into a crank web and fitted to keep crankpin from turning.

**Check ring.** A ring fitted to protect anything. One is often used to prevent the starting of the junk-ring bolts in a piston.

**Check rope.** A rope one end of which is fastened to some object ashore, the other being kept on board the vessel round a bitt; it is held slightly or firmly taut to lessen or stop the way of a vessel as required.

**Check valve.** A valve so made as to allow passage in one direction only.

**Cheek blocks.** Blocks having one side formed for fitting against a spar.

**Chimes.** The intersection of the lines forming the sides and the bottom of a flat-bottomed boat.

**Chinsing.** The act of forcing cotton or oakum into the seams of boat planking.

**Chipping.** Cutting a surface smooth or an edge fair to a line with a chipping tool, generally air driven. See Plate LIII.

**Chock.** A block of wood used to prevent anything from shifting when a vessel rolls. A guide for a rope or chain, usually of metal.

**Circulating pump.** A pump to

force cold water through a condenser to condense the steam.

**Clack.** A check valve with swinging check.

**Clack box.** The body of a clack valve.

**Clack door.** A plate of iron covering hole in clack box, which may be removed to get at valve.

**Clamp.** An iron device to grip wire ropes.

**Clamp.** A device for securing two pieces of material together.

**Clamp of a forecastle.** A strake of planking under forecastle deck beams.

**Clamp of poop.** A strake of planking under poop deck beams

**Clamp of raised quarter deck.** A strake of planking under raised quarter deck beams.

**Clapper.** A fitting between the jaws of a gaff to prevent it from jamming as it descends the mast. Sometimes called a tumbler.

**Clasp hook.** A hook which clasps a ring, or stay, or rope. It is included in the general term hank.

**Classification.** The act of granting a class or character to a vessel by a classification society.

**Clean.** The sharp part of a ship's hull, under water, both forward and aft.

**Clearance of piston.** The distance between the piston and cylinder head at the extreme position of the stroke.

**Cleat, kevel, or cavil.** A species of hook, usually having two arms, fastened to the deck or any other suitable and convenient part of a boat, around which sheets, halliards, spring, etc., may be wound without being knotted. Cleats are of various forms.

**Clench or clinch.** To jam down with ropes; to jam down by a half hitch.

**Clew.** The clew is the lower corner of a sail, and unless otherwise described is the after lower corner.

**Chain cable compressor.** A device for controlling the mooring cable as it runs out. When clamped it will hold the cable secure as the ship rides at anchor.

**Chain drum** (of a steering engine). A heavy piece of metal of cylindrical form, having deep spiral grooves for the steering chain to travel in.

**Clinch.** The end of a rope passed in the form of a half-hitch, round itself.

**Clinched bolt.** Any bolt having a head on one end, clinched, i.e., bent over or hammered flat at the other end when driven home.

**Clinching pan.** A small steel plate used by a mold loftsman to clinch the nails used in building molds.

**Clinker strake.** A strake of plating having one edge under and the other edge above adjoining strakes.

**Clip.** A short angle connecting shapes and plates. See Plate LXII.

**Close ceiling.** Ceiling planks the edges of which are fitted close against each other and well fastened.

**Closed-in bridge.** A bridge house having a bulkhead at each end.

**Clump blocks.** Strong hoisting blocks with thick sheaves and large swallows.

**Clutch.** A mechanism used to connect two shafts in such a manner that one of them may be stopped or started while the other continues in motion. There are many designs, but the disc clutch and the cone clutch are the two types in most general use.

**Clutch pinion.** A wheel brought into connection with another wheel or shaft or disconnected from same by means of a clutch.

**Coal-bunker lid, coal-bunker pipe lid.** A cover by which a coal-bunker pipe is closed.

**Coal bunkers.** Specifically, in steamships, the place where coal for the furnace is stored.

**Coaling hatchway.** An aperture in a steamer's deck through which the coal for consumption during the passage is shipped.

**Coaling port.** An opening or door in the side of a vessel through which coal is passed for bunker use.

**Coaming.** A raised edge or planking round a hatchway of a ship or well of a yacht. Its use is to prevent any water which may wash over the deck from getting down below.

**Cockpit.** Formerly, an apartment under the lower gundeck of a ship of war, forming quarters for junior officers, and during a battle devoted to the surgeon and his assistants and patients.

**Cockswain.** The person who steers a boat.

**Cofferdam.** In a warship, a series of watertight compartments, in the vicinity of the water line above the protective deck, built in the interior against the ship's side; can be packed to prevent water from entering after the side has been pierced by shot. Also, double watertight bulkheads forward and aft of engine and boiler rooms.

**Coir-rope.** A rope made from the outer fiber of cocoanuts.

**Collar.** A raised portion in the form of a ring on a shaft or similar part of an engine. A piece of plate, or angle bar forged in "U" form fitted around keelsons and stringers where they pass through a bulkhead for the purpose of making it watertight. See Plate LX.

**Collier.** A vessel employed in the coal trade. A naval vessel for delivering coal.

**Collision bulkhead.** A strong bulkhead built across a ship, near the bows, and designed to prevent it from filling with water if the bows are stove in. See Plates IX and XII.

**Column.** A pillar or stanchion. See Plate XXV.

**Columns, back and front.** Frames supporting cylinders of engine. See Plate XXXVI.

**Companion ladders.** Ladders or staircases in a ship.

**Compass.** An instrument having one or more magnetic needles attached to a circular card which turns freely on the point of a steel cone, or floats on a liquid. The upper surface of the card is divided into the 32 points of the compass, used to get direction.

**Composite.** A system of building large ships with an iron framing and wood skin.

**Condenser.** An apparatus for condensing steam from an engine. See Plates XXXVII and XLII.

**Condenser auxiliary feed connection.** The valve that takes circulating water in with condensed steam.

**Condenser auxiliary feed.** The pump connection to boiler (for condenser).

**Condenser auxiliary exhaust.** The connection from auxiliary engine.

**Condenser discharge water pipe.** The pipe by which discharged water (circulating) is led from condenser. See Plate XXXVII.

**Condenser door.** The movable lid closing the end of a condenser.

**Condenser head.** A part flanged to bolt on over the tube plate and to receive the condenser door. It is fitted with a dividing wall that causes the circulating water to go through half the tubes and to return through the other half. See Plate XXXVII.

**Condensing engines.** Engines in which the steam after performing its work in the cylinder is led into the condenser.

**Condenser eduction pipe** (from engine to condenser). Pipe leading exhaust steam from cylinder to condenser. See Plate XL.

**Condenser, jet.** A condenser in which steam is condensed by mingling with jets of cold water.

**Condenser, surface.** A condenser in which steam is condensed by contact with the surface of tubes containing cold water.

**Condenser tubes.** The numerous small tubes closely fitted in a surface condenser.

**Condenser tube ferrule.** A piece of brass tube threaded on outside, which screws in the condenser tube plate to hold packing in place around the end of the tube.

**Condenser tube plate.** A brass plate into which ends of condenser tubes are fastened.

**Condenser tube rest plates and support plates.** Plates in center of condenser supporting weight of tubes.

**Condenser vacuum gauge.** A gauge for ascertaining the amount of vacuum in a condenser.

**Condenser water inlet.** The inlet for water for condensation purposes.

**Connecting bridge, flying bridge.** A narrow platform of planking supported by stanchions, forming a fore-and-aft gangway from a poop to a bridge deck, from a bridge to a forecastle deck, etc., and generally fitted with guard rods and stanchions.

**Connecting bottom end distance piece.** A piece of metal so placed as to adjust the distance between the centers of the crank and crosshead pins, thus giving proper clearance for the piston at each end of the stroke.

**Connecting plate.** Any plate used to connect other plates or parts.

**Connecting rod.** The rod connecting the crankpin and crosshead. See Plate XXXIV.

**Connecting-rod bolts.** The bolts by which the top and bottom end brasses and keepers of a connecting rod are adjusted and held in position.

**Connecting-rod brasses.** Brass bearings at each end of connecting rod, to take crankpin and crosshead pin, and known as top-end and bottom-end brasses, respectively. See Plate XXXIV.

**Connecting-rod keepers.** Keepers are metal pieces to hold brasses in place, used at both ends of rod and known as top-end keeper and bottom-end keeper, respectively.

**Connecting-rod liners or shims.** The sheet metal between brasses which may be removed as required to take up wear of brasses.

**Continuous floor.** A floor in the construction of a cellular double bottom. It is continuous from the center girder to the bilge.

**Control gauges.** Gauges for engineers' use. See Plate XLII.

**Cooling pipe.** A pipe through which water is led to cool cranks and other working parts of an engine.

**Cordage.** The supply of ropes and cords aboard a ship.

**Corrugated furnace.** A furnace or firebox formed of corrugated steel.

**Counter.** That part of a vessel's body which projects beyond her sternpost.

**Counterbore** (v). Increasing the size of a hole part way, keeping the sides parallel.

**Counterbore** (n). A tool for counterboring.

**Counter plate.** Any plate in the lower stern in proximity to the rudder post.

**Counter rail.** A batten fitted at the margin of a square or the knuckle of an elliptical stern.

**Countersink** (v). To increase the size of a hole, giving the sides a slant.

**Countersink** (n). A tool for countersinking.

**Countersunk.** The form of a rivet or bolthead when it is like a flat-head wood screw, done so that they may not protrude beyond the surfaces they hold down.

**Coupling.** Any contrivance adapted for connecting the adjoining ends

of shafts or pipes, as by coupling flanges and bolts.

**Coupling bolts.** Bolts of special design for couplings.

**Coupling box.** See Box coupling.

**Coupling flange.** A flange on a shaft or pipe.

**Crab winch.** A small winch.

**Cradle.** A framework of timber under the bottom of vessels when launched. See Plate XVI.

**Cradle.** A mold for shaping a plate.

**Craft.** A term applied to any kind of a vessel, but chiefly used to denote one of small size.

**Crane.** A machine for hoisting and moving heavy pieces of material or equipment.

**Crank or cranky.** A vessel is said to be cranky when she fails in the quality called stiffness, or when she careens over to a large extent in a light breeze, and, therefore, cannot carry much sail.

**Crank bearing.** The bed in which the journal of a crankshaft rests or revolves.

**Crank disc.** A disc on the end of a shaft, carrying the crankpin.

**Crank hatch, crank hatchway.** The opening in the deck above the engines of a paddle steamer, usually covered by a skylight.

**Crankpin.** The circular short pin of steel projecting from a crank-web, or fitted between the two webs of a crankshaft.

**Crankshaft.** The main shaft in a reciprocating engine. It contains the cranks that convert the up-and-down motion of the piston into the rotary motion of the shaft. See Plate XXXII.

**Crank web.** The flat plate or arm connecting crankpin to shaft. See Plate XXXIV.

**Cribbing.** The blocking under the keel blocks. See Plate I.

**Cringles.** Loops or eyes formed in the bolt ropes of sails. Through them ropes are passed so as to gather up the margin of the sail; and to them pendants are hung for tying down the sail in reefing.

**Cross bearing.** Ascertaining the position of a vessel when near a coast, etc., by taking the bearings of two objects marked on the chart, having the necessary distance from each other for accurate observation.

**Crosshead.** The connecting part between a piston and a connecting rod on a pump or an engine. See Plate XXXV.

**Crosshead guide.** A piece of hard smooth faced metal fitted on the inside of a cylinder column, etc., on which the shoe of the crosshead slides. See Plate XXXV.

**Crosshead pin.** A pin connecting main rod and crosshead. See Plate XXXIV.

**Crosshead links** (pumps). Links connecting crosshead and pump lever.

**Crosshead nut.** A nut which prevents piston rod from turning in or out of crosshead.

**Crossjack.** The lowermost square sail on a mizzen mast.

**Crosstrees.** The arms extending near the head of a mast at right angles to the length of a vessel, and to the extremities of which the topmast shrouds are stretched for the purpose of giving support to the topmast.

**Crotches.** Timbers placed upon the keel in the forward and after parts of a vessel, where her form grows narrower (in wood ships).

**Crown.** A term applied to the covering or top of various receptacles in a ship.

**Crown sheet.** The plate forming the top of the firebox in certain types of boilers.

**Crown of a double bottom, crown of a tank.** The cover of iron or steel plates on a tank. It is always fitted with manholes giving entrance to the interior. The curvature given tank top or deck.

**Crown plate.** A plate forming a crown or part of one.

**Cruiser.** A boat or warship which is intended for extended voyages; with yachts the word is used in contradistinction to racers.

**Crutch.** A triangular-shaped plate, fitted horizontally in the lower after extremity of a vessel to connect the end stringers, etc., at this part of a ship.

**Crutch.** A trestle supporting the boom of a fore-and-aft sail when at rest. Its use is to take the weight of the boom off the halliards. Metal rowlocks are occasionally called crutches.

**Cuddy.** On shipboard, a small cabin; sometimes the cookhouse, on deck.

**Cutter.** A large boat used by ships of war.

**Cut-off valve.** A valve, usually fitted on the back of the ordinary slide valve, for the purpose of "cutting off the steam" before the piston has completed its stroke; the portion of steam admitted finishing the stroke by expansion.

**Cutwater.** That portion of the stem of a vessel which cleaves the water as she moves.

**Cylinder columns.** Vertical supports of the cylinders and other elevated parts of an engine. See Plate XXXVI.

**Cylinder cover, cylinder head.** A movable lid fastened by bolts, or studs, and nuts on one end of a cylinder.

**Cylinder drains.** Valves at end of cylinders to drain off condensed steam. See Plate XXXVI.

**Cylinders, engine.** The chambers where the steam operates and the pistons travel. See Plate XXXV.

**Cylinder-head studs.** Studs which hold cylinder head in place.

**Cylinder lagging.** A covering round a cylinder, encased by wood or metal, etc.

**Cylinder valve chest or receiver.** A chamber containing valve for steam distribution to cylinder.

**Cylinder valve chest cover.** A cover by which valve is accessible.

**Cylinder valve chest cover studs.** Studs to hold cover in position.

**Cylinder valve face.** The seat on which valve controlling the admission of steam travels.

**Cylinders.** Chambers where engine pistons travel and steam operates. See Plate XXXV.

**Cylindrical boiler.** A boiler of cylindrical form, now in general use, adapted to stand the increased high pressure employed.

**Dash plate.** A plate fitted in an apparatus to receive the impact of steam, water, etc.

**Davit.** A light crane on a ship's side for lowering and lifting boats. The projecting beam over which the anchor is hoisted is sometimes called a davit.

**Davit guys.** Ropes or chains fastened to anchor davits, boat davits, etc., to keep them in the desired position.

**Davits, rotating.** Davits which turn or "swing around" in their supports. (Most common type of davit used on shipboard.)

**Davit socket.** A socket in which the heel of a davit rests, and in which it can be turned.

**Davits, swan-neck.** Davits that tip outward when lowering a boat, and are curved so as to come inboard of it when stowed. (Used mostly for torpedoboat destroyers and small craft on account of their lightness and adaptability to the restricted deck area and because of their speed and ease of operation.)

**Deadeye.** A flattened circular piece of wood perforated for the reception of lanyards.

**Dead flat.** A portion of ship's bottom or side where plating has no curvature.

**Deadlight.** Any cover or shutter fitted to protect the glass of a skylight, cabin window, etc., i.e., to prevent the wash of the sea breaking the glass and entering the apartments.

**Dead plate.** A cast-iron plate at the front of firebox to support the front ends of the grates.

**Dead point, dead center.** A position of the crank in which crank axle, crankpin and connecting rods are in a straight line, i.e., at the extreme position of the stroke.

**Dead rise.** The amount that the lower edge of bilge strake stands higher than the keel.

**Dead sheave.** A half sheave not revolving inserted anywhere for ropes to pass over while fixed in its position.

**Dead weight, cargo faction.** To ascertain approximately the dead-weight cargo in tons which a ship can carry on the average length of voyage. (Rule: Multiply the number of registered tons by 1.5, and the product will be the approximate dead-weight cargo required.)

**Dead weight.** When cargo weighs more than 50 lbs. per cubic foot it is spoken of as dead-weight cargo; frequently a vessel's cargo capacity is spoken of as so many tons dead weight.

**Dead work.** The topside of a vessel, i.e., that portion of the hull above the water line.

**Deck.** The covering of the interior of a ship, either carried completely over her or only over a portion.

**Deck, awning.** A light deck built to shelter the deck below.

**Deck, bridge.** A partial deck extending from side to side of ship, about amidships.

**Deck, forecastle.** A partial deck at bow of ship, raised above weather deck.

**Deck, hurricane, or boat deck.** The uppermost deck; deck where boats are stowed.

**Deck, lower.** The first full deck above tank top.

**Deck, main or 2d.** The second full deck above tank top or bottom of ship. See Plate XIII.

**Deck, poop.** A partial deck at stern of ship, raised above weather deck.

**Deck, promenade.** A deck above an upper deck, set aside for use of first-class passengers on passenger ship.

**Deck, upper or 3d.** Third full deck above tank top or bottom of ship.

**Deck beam.** A beam which supports a deck. See Plate XII.

**Deck beam clamp.** A clamp under a tier of beams of any deck.

**Deck beam stringer plate, deck stringer plate, deck beam stringer.** A plate stringer placed on the beam ends of any deck. The stringers take their names from the beams of the various decks on which they are laid. See Beam stringer. See Plate XIII.

**Deck beam tie plates.** Tie plates on beams of unplated deck.

**Deck bolts.** The bolts by which deck planks are fastened to the beams.

**Deck cargo.** Any cargo stowed on a vessel's deck.

**Deck carlins.** Light beams supporting a deck. See Plate XV.

**Deck ends.** The ends of planks forming a deck.

**Deck girders.** Continuous longitudinals fastened under the deck, or fitted intercostally. See Plate X.

**Deck hooks.** Pieces connecting the extreme fore ends of deck stringer plates.

**Deck house, round house.** A structure from 6 to 7 feet in height on the upper deck, but not extending from side to side of the vessel as in the case with a bridge house a forecastle a poop, or raised quarter deck; usually containing crew-space galley, carpenter's workshop, etc.

**Deck light.** A piece of thick glass, the upper surface of which is flat and the lower part angular, inserted in a wooden deck for light.

**Deck line.** The line from forward to aft where a deck touches the ship's side.

**Deck plan.** A drawing showing the layout of a deck.

**Deck stoppers.** A strong stopper used for securing the cable.

**Deck pillar.** A pillar fitted to support a deck.

**Deck planks.** The wooden planking, covering deck beams extending fore and aft.

**Deck plating.** Plates covering deck beams and thus forming an iron or steel deck.

**Deck stringer angle bar.** An angle bar used to secure stringer plate of any deck to shell plating.

**Deck stringer inner angle bar.** Any angle bar connected to a deck stringer and forming inner boundary of waterway.

**Deck stringer outer angle bars.** Short angle bars fitted between the frames to connect the outer edge of a deck stringer plate to the outside plating.

**Deck transom, transom beam.** A beam situated at the level of a deck to receive the fastenings of the after end of the deck planking. See Plate XI.

**Deck transversals.** See Deck beams.

**Deep floors.** Floors in the fore and after ends of a vessel, so called on account of their greater depth. See Plate XXV.

**Deep tank.** A tank extending from the floors up to a lower or main deck, and from side to side of a vessel.

**Deep water line.** The line to which a vessel is submerged with a full cargo on board.

**Delivery pipe.** Any pipe through which water is led, and delivered, for instance, into a boiler, a water-ballast tank, etc.

**Delivery valve.** Any valve through which water, etc., is delivered.

**Depth, depth measure.** The distance from the underside of the deck beams to the keelson, measured inside.

**Depth of hold.** The depth from the main deck down to the ceiling.

**Derrick.** A crane, consisting of a beam and mast with tackles, for raising or lowering weights, the foot of which rests either upon the ground or at the lower end of a mast, used to hoist heavy weights, cargo, etc.

**Disc cutter.** See Rotary shears.

**Distortion.** The result of excessive strains that cause a plate or a form to lose its proper shape.

**Displacement.** Total weight of ship and all on board when at sea. It is equal to the weight of water displaced.

**Dock.** An excavation of large area, for the reception of vessels. It may be either a wet dock, in which ships are loaded and unloaded, or a dry dock, in which they are either built or repaired.

**Docking keels.** See Bilge keels.

**Dockyard.** A place where ships are built or repaired.

**Dog.** A piece of iron or steel wrought into a semicircular shape, and of sufficient span to cross a manhole, over which it is placed, and held by a stay passed through the manhole door up to the head; the free end extending through the arched center of the dog, where

it is tightened by a screw nut, till the lid or door is securely closed and held in position. A short piece of iron rod bent nearly double, with one leg longer than the other, used by furnace men to secure work to bending slab.

**Dollybar.** A holding-on tool for riveting. A bar, offset or with a bevel-faced end, made to use where obstructions make it impracticable to use a holding-on hammer. See Plate LV.

**Dolphin.** A bollard on a pier-head, etc., or a pile driven into the bed of a river, to which ropes are fastened when moving the vessel by hauling.

**Donkey boiler.** A small boiler for operating auxiliary engines.

**Donkey engine.** A small engine for pumping, hoisting, etc.

**Double bottom.** A structure consisting of girders, angle-bars, plating, etc., etc., several feet in height, in the lower part of the vessel, notably of steamers, extending from bilge to bilge and in some vessels nearly the whole length of the ship. See Plate III.

**Double keel.** Two plate keels, one above the other, called inner and outer keel, respectively. See Plate VI.

**Doubling plate.** A plate fitted inside or outside of another plate to insure strength.

**Draft, draught** (of a vessel). The depth of the submerged part of a ship, i.e., vertical distance from surface to lowest part of vessel.

**Draft marks.** Marks painted on bow or stern to show depth to which a vessel is loaded. See Plate XV.

**Drag links** (sometimes known as Stevenson links). The curved slotted links forming a part of the reversing mechanism. See Plate XXXVI.

**Drag-link rods.** Rods which transmit throw of weigh shaft to quadrant. See Plate XXXVI.

**Drain cocks.** Cocks fitted to drain a cylinder. See Plate XXXIV.

**Dredge.** A dredge, or dredger, is a machine for clearing or deepening rivers, canals, etc.

**Drift pin.** A small tool used to draw adjoining parts in line so that the rivet holes will coincide.

**Drill drift.** A tool for removing a drill from the socket.

**Drilling machine.** A machine for cutting holes in metal, rock, etc. See Plate LIV.

**Drillers.** Men who drill holes in a ship's structure. See Plate LIV.

**Drills.** Tools for boring holes in metal, stone, or other hard substances.

**Drop strake.** A strake of plating or planking not extending, like other strakes, from end to end of a vessel.

**Dry-bottom boiler.** A boiler having no water space below the furnace.

**Drydock.** An excavated place, near a wet dock or a river, of oblong form, having a very firm foundation, and the sides usually lined with stones, sometimes with wood. At one end gates are fitted and water permitted to fill it. A vessel is hauled in and water removed to permit work being done on her.

**Dub** (in shipbuilding). To work with the adze on a spar or timber; to smooth off planking.

**Dunnage.** Loose wood or rubbish placed at the bottom of the hold to raise the cargo either for purpose of ballast, or to keep it dry.

**Eccentric rod.** A rod connecting eccentric sheaves with reversing link. See Plate XXXVI.

**Eccentric sheaves.** The main part of the eccentric, fastened to the shaft and revolving with it. See Plate XXXVI.

**Eccentric sheaves key.** A key holding sheaves in position.

**Eccentric strap.** The part of an eccentric surrounding the sheave. See Plate XXXVI.

**Engine-room casing.** A wall around engine room. See Plate XXXIX.

**Engine-room control valve.** The main valve in steam line. See Plate XXXVI.

**Engine telegraph.** See Telegraph.

**Ensign.** The flag hoisted at the stern to indicate the nationality of the ship.

**Entrance.** The point of the bow which enters the water as the ship moves forward.

**Escape valve.** A relief valve on an engine cylinder (generally on a low-pressure cylinder) to protect it from dangerous steam pressure. See Plate XXXIX.

**Even keel.** A vessel is said to be of even keel when her draft forward and aft is alike.

**Exhaust lines from seals.** Pipes taking steam from seals. See Plate XLIII.

**Exhaust line to condensers.** The pipe that takes steam from engine to condenser. See Plate XL.

**Expansion trunk.** The upper portion of a tank on an oil tanker, used to allow for the expansion of the oil. With any fluid cargo large tanks must be kept full or the movement of the cargo will endanger the vessel. To effect this, comparatively small chambers are continued above the tank proper.

**Eye.** The eye or loop in bolt or a rope.

**Face plate.** A plate fitted vertically against the edge of a horizontal plate; for instance, on the inner edge of an orlop or hold stringer plate.

**Fabricate.** To punch, cut, shear, drill, bend, flange, rivet, or weld plates and shapes. See Plate XLVIII.

**Fair curves.** The lines of a boat, either vertical, horizontal, trans-

verse, or sectional, which are regular even curves without any severe or sharp angular bends.

**Fair, to, or fair up.** Connecting or fairing up ship's lines on mold loft floor. On wood ship, to smooth off planking or ceiling.

**Fairleads.** Fittings through which a line or chain is led to change its direction without excessive friction.

**Fair ship.** To keep ship plumb on ways while under construction.

**Fake** (of a coil of rope). One of the rings forming a coil of rope.

**Fake** (v.). To coil or to place in some regular fashion so that a rope or chain will "run clear."

**Fall.** That portion of a tackle rope to which the power is applied. This term is also given to ropes employed to form tackles.

**False keel.** An addition to the main keel. It not only acts as a protection to the main keel, but enables the vessel to take a better hold of the water.

**False post, false sternpost.** A piece of timber of less molding than a sternpost, fitted and bolted to the after part of the latter, for additional strength.

**Fantail.** The overhang of a vessel's stern when it extends unusually far and deck is rounded at stern.

**Fashion pieces.** The aftermost timbers of a vessel which form or fashion the shape of her stern.

**Fathom.** A measure of length for ropes, etc., and for measuring the depths of soundings taken. In England and America, 6 ft.; in France, about 5 ft. 3/4 in.

**Fay.** To join two pieces of timber by thinning down the ends and fitting to each other.

**Faying surface.** The surface between two adjoining parts.

**Faying side.** The side of plate punch enters from, i.e., plates are punched from side that is to bear on other plate, to avoid the burr that is made by the punch.

**Feathering paddle** A paddle wheel in which the blades are so constructed and arranged as to enter and leave the water edgewise, or as nearly so as possible.

**Feed cock.** A cock to control the flow of feed water.

**Feed heater.** An apparatus in which the feed water is heated by steam before entering the boiler.

**Feed pump.** The pump by which boilers are supplied with water, usually from the hotwell of the air pump

**Fender.** A device to prevent chafing or bumping, made of wood, rope, or cork.

**Ferry.** A vessel or boat passing constantly to and fro across a river, or some narrow water, for the transport of passengers, live stock, goods, etc.

**Fid.** A bolt of wood or iron which fixes the heel of a topmast or bowsprit. The fid of a mast rests, when the topmast is lifted, in the fid holes upon the trestle

trees, thereby preventing the topmast from coming down.

**Fiddle block.** A block with one sheave larger than another, and which, therefore, can take two sizes of rope. Sometimes called a thick-and-thin block.

**Fidley.** An iron casing enclosing the foot of a funnel, above the stokehole, sometimes also the boiler hatchway. It is fitted with bar gratings, "fidley gratings," and lids, which may be opened or closed according to the weather.

**Fidley hatch.** Same as fidley.

**Fiferail.** A rail fitted around masks, pumps, etc.; takes belaying pins to which running gear is made fast.

**Fillets.** Filling of an inner angle of a forging or casting to strengthen it.

**Firebars, furnace bars.** Iron bars laid as a grate in a furnace, on which the fuel is placed for consumption.

**Firebar bearers, furnace-bar bearers.** The supports in a furnace upon which the firebars rest.

**Firebox.** The part of a boiler containing the furnace.

**Firebox straps, combustion-chamber stays.** Stays between the back end plate of a boiler and the back plate of a combustion chamber.

**Fire slice, slice bar.** A tool used by the fireman to clean a fire.

**Fish tackle.** See Cat-and-fish tackle.

**Fireman's cocks, ash cocks.** Cocks serving to supply water to be poured on hot ashes to quench any fire smouldering in them.

**Flange.** The bent or curved edge, or rim of a pipe, or cylinder. They are "turned up" on a shaft or a removable propeller blade, made separate and screwed on pipe.

**Flange joint.** A flange joint is made by two flanges bolted together.

**Flanged plate.** Any plate bent in a more or less angular form; for instance, on a bracket or floor plate, a plate with a bent or curved edge. See Plate VI.

**Flare or flam** (a flying out). The outward and upward curve of a vessel's bow.

**Flat.** A small partial deck built without curvature.

**Flat floor.** The lower portion of a transverse frame, usually a vertical plate extending from center line to bilge and from inner to outer bottom without camber.

**Flat of bottom.** The nearly horizontal portion of a ship's bottom.

**Flat-plate keel.** A keel consisting of plates about the same length and about ⅓ more in thickness than the garboard-plates and fitted horizontally at the center line, under the floors, in lieu of a bar keel. See Plate II.

**Flat-plate keelson, flat keelson plate.** A range of plates placed horizontally on the top of the

keelson and floors, connected to each other lengthwise and riveted to double angle bars fitted on the upper edge of the floors.

**Floors.** That portion of the transverse frames of a vessel which extend from bilge to bilge and connect to keel and keelson. See Plate XX.

**Floor ceiling.** That portion of the ceiling placed horizontally, or nearly so, above the floors.

**Floor head.** Either end of a floor.

**Floor-head chock.** A piece of shaped wood, serving to connect a floor head with the heel of a buttock.

**Foot grating.** A grating placed usually in the after end of a boat, covering the well, serving for a foothold for the person steering.

**Floor plates.** Plates placed vertically in a vessel's bottom, extending from bilge to bilge, usually in way of every frame, in which the lower edge of each is connected and to their upper edge the reversed frames are riveted. See Plates VI and XX.

**Flush deck.** A continuous deck without break.

**Flush-deck vessel.** A vessel having a continuous upper deck without any break or erection, as forecastle, poop, raised quarter deck, or other structure extending from side to side of a vessel.

**Flush-head rivet.** A rivet the head of which does not extend above the surface of the plate, angle bar, etc., into which it is driven.

**Fly** (of a flag). Its length; that part of a flag which is farthest from the mast. The card upon which are marked the points of the compass.

**Force pump.** A kind of pump used to throw water to a distance. It has two sets of valves; one holds intake on return stroke, the other set keeps that which has been forced from piston chamber from returning.

**Fore, fore part** (of a vessel). The forward end.

**Fore and aft.** In line with the ship's keel; as, fore-and-aft deck line girders.

**Forecastle.** A structure upon the upper deck of a vessel; in steel ships, generally extending from side to side and from the forepeak aft to end of the forecastle deck. The crew's quarters.

**Fore foot.** That part of the keel which curves and runs to meet the stem.

**Fore hooks.** Strengthening timbers in the bow of a vessel, binding the other timbers together.

**Fore lock.** A sort of linchpin or split pin through the end of a bolt to prevent it from getting out of position. Also, the braces of the rudder.

**Foremast.** The lower mast nearest to the stem, in all vessels having two or more masts.

**Fore-peak.** The extreme fore end of a vessel's hold.

**Fore rake.** The forward inclination of the stem of a vessel, or of a topmast, etc.

**Forestay.** A rope or wire running from a masthead to the stem of a vessel, or to the bowsprit end. It prevents the mast from falling backward under the weight of the sails.

**Forereach.** To overtake another vessel and reach ahead of her.

**Fork beam.** A small forked beam which supports a deck where a hatchway occurs.

**Forming.** Shaping partially converted timber or plates so as to give them the desired form for building.

**Forward.** In front of; towards the bow.

**Forward part.** The fore part, in the bows of a vessel.

**Forward quarter.** A section of the bow on either side between the stem and side.

**Foul.** A vessel is said to be "foul" when barnacles, grass, etc., adhere to her bottom, and accumulate in such quantities as to impede her progress. A ship's anchor is foul when the cable has caught the flukes or the stock. A tackle is foul when the fall is jammed in the blocks, etc.

**Found, all found.** A vessel or boat is said to be "all found" when she has masts, rigging, and gear, and all other necessaries for going out, and "well found" when all these are good.

**Foundation plate, sole plate.** A plate to which an engine or pump, etc., is bolted. A plate forming part of a foundation.

**Founder.** To fill with water and sink; to miscarry.

**Frame.** The skeleton of a vessel; all the structure to which deck and shell plating or planking is fastened. See Plates XIII, XIV and XVI.

**Frame angle bars.** The angle bars of which a frame of any kind is constructed.

**Frames, cant.** A group of frames (cant frames) extending over the rudder, forming the stern of the ship; i.e., frames not at right angles to the keel. See Plate XI.

**Frame mold.** A template for the frame of a ship.

**Frames, reverse.** Angles at top of floor plates; angles forming part of a frame but in a reversed position to the angle joining the shell plating.

**Frames, side.** Frames in the side above and connecting with the margin plates. See Plate XIV.

**Freeboard.** The distance from the water's edge to the top of the deck at the side; that part of the side of a vessel or boat which lies between the line of flotation and the upper side of the ship's decks when loaded.

**Freeing port.** An opening in the bulwark for discharging large quantities of water, when thrown

by the sea upon the ship's deck.

**Fuller.** A tool for setting out or offsetting.

**Funnel.** A large sheet-iron tube, extending from the uptake high above the deck, through which the smoke and gases pass.

**Furnace.** A casing or tube of large dimensions inserted in a boiler, fitted with a fire grate on which the fuel to raise steam is fired and tended. That portion below the fire grate is termed "ash pit."

**Furnace bridge, fire bridge.** An iron plate supporting layers of fire-brick forming the raised end of a furnace, the object being to offer as much obstruction as possible to the too quick passage of the liberated gases, and gain more perfect combustion.

**Furnace crown.** The upper portion of a furnace.

**Furnace door.** A door in the front of the firebox for firing.

**Furniture.** The masts and rigging, etc.

**Gaff.** A spar having usually at one end a jaw partially clasping the round of a mast, and to which the top of a fore-and-aft sail is attached.

**Galley.** The kitchen of a vessel.

**Galley dresser.** A cook's work table.

**Galley funnel.** A sheet-iron or brass tube through which smoke is conveyed to the open air from galley stove

**Galvanizing.** Dipping iron or steel forms, after they have been cleaned, into a bath of melted zinc; done as a protection against rust.

**Gammoning.** An iron hoop, a rope, or chain lashing placed round a bowsprit immediately outside of its bed, fastened to some extreme fore end of the vessel, to assist the bobstays in keeping the bowsprit in its bed.

**Gangboard.** A board used for getting on board a vessel from a quay or pier; i.e., "gangplank."

**Gangway.** The sides of the upper deck, from the mainmast to the mizzen mast, or from the former to the break of a poop, or raised quarter deck; also, passage for entering or leaving a vessel.

**Gangway.** A narrow platform or bridge from one deck of a vessel to another.

**Gantline, girtline.** A rope rove through a single-sheave block, by means of which anything is hoisted aloft from the deck or lowered from aloft to deck.

**Garboard.** The lowest part of a vessel.

**Garboard strake.** The lowest strakes in a vessel, which abut upon the keel. Sometimes called sand strakes. See Plates VI and VIII.

**Garland.** A ring of rope placed round a spar for the purpose of

moving it, as, for example, swaying a heavy mast.

**Gaskets.** Ropes used to hold furled sails to the yard or boom; packing on manhole doors of boiler and on all watertight doors or hatch covers, on cylinder heads or pipe flanges.

**Gauge glass, water gauge glass.** A thick glass tube, attached to a boiler or the water gauge column, in communication with the water in the boiler to indicate its level.

**Gear.** A general term applied on board a vessel to sets of ropes, blocks, etc., used in working a sail.

**Gauge pipe.** A pipe through which water or steam is conveyed to the gauge.

**Geared engine.** An engine equipped with gearing to increase the speed of the screw shaft.

**Gib.** A wedge-shaped piece of metal that holds another in place or presses two pieces together. (Used to take up wear, as on a crosshead guide.)

**Gig.** A long narrow boat of good pattern, chiefly for the shipmaster's use when going ashore or returning to his vessel.

**Gimbals.** A contrivance by which the ship's compass is kept horizontal while the vessel is rolling and pitching. (Consists of two concentric rings pivoted at right angles to each other.)

**Gin blocks.** Blocks used on derrick heads and spars in conjunction with a whip for handling cargo, and consisting of a skeleton frame and sheaves of iron.

**Girder plate.** Any plate used in forming a girder.

**Girders.** Members of ship's frame running fore and aft under deck beams to support them.

**Girdle.** Extra planking over the wales or bands of a vessel.

**Girth.** The distance in a frame from gunwale to gunwale.

**Gland.** A flanged tube partly inserted in a stuffing box, to compress the contained packing.

**Gland packing.** The packing in a stuffing box compressed by the gland.

**Goose.** The fittings of a boom to a mast by means of a curved pin or hook in the heel of a boom which fits into a ring or short cylinder on the mast.

**Gore strake.** An angular piece of planking or a strake, terminating short of the stern or stem.

**Gores, goring.** The angular piece of canvas in a sail, which makes the foot broader than the head.

**Gouge.** A chisel with a half-round edge.

**Governor.** A device for automatic control of engine speed. See Plate XLI.

**Grab stand.** A special rig used to hold an electric or air-drilling machine, when drilling.

**Grapnel.** A small stockless anchor, having usually 4 or 5 flukes, used chiefly for anchoring ship's boats, or for recovering something lost overboard or off a dock.

**Grate, fire grate.** The bars on which fuel is burned under a boiler.

**Grating.** A lattice-work of wood or metal. See Plate XXXIX.

**Grating, hatch.** A grating fitted over a hatchway to replace solid hatches.

**Grease cock, tallow cock.** A cock, one end passing just through the boiler's front, the other tapped for a syringe to be screwed on, for the injection of melted tallow or oil, to lessen the priming of the boiler.

**Gridiron.** A framework of stout timber bedded on a firm bottom at a river side, over which a vessel may be hauled at high tide. It takes the place of a drydock.

**Grommet.** A ring made of a single strand of rope used as a saddle under the eyes of standing rigging.

**Gross tonnage.** The whole cubical capacity of every enclosed space on board of a ship, including all the room under deck, from stem to sternpost, if closed in and usable.

**Ground blocks.** See Sleeper and Plate I.

**Ground tackle.** A vessel's bower anchors and chain cables.

**Ground ways.** See Ways and Plate XV.

**Gudgeon.** A pin or journal to which other working parts can be attached, as the air or circulating pump gudgeons, link gudgeons, etc. (For rudder gudgeon, see Rudder braces.)

**Guide rod, tail rod.** Any lengthened portion of a rod working in a guide, as the tail end of a piston rod moving through the aperture in a cylinder cover, which forms a guide.

**Guide block, guide shoe.** A flat piece of metal attached to the crosshead of a piston rod and working on the face of the guide, by which its motion is directed.

**Gunwale, gunnel.** The upper part of the sheerstrake, i.e., where it comes in contact with the upper deck stringer.

**Gunwale angle bar.** An angle bar connecting the outer edge of an upper deck stringer, poop, bridge, or forecastle deck stringer, to their respective sheerstrakes.

**Gunwale plate.** A term sometimes given to the stringer plate of an upper deck, poop bridge, etc.; also, one used in the forming of a rounded gunwale.

**Gunwale stringer.** The stringer of any weather deck, i.e., of an upper, spar, awning, shelter, bridge, forecastle, poop, or raised quarter deck.

**Gusset, gusset plate.** An angular plate fitted horizontally for strength and connection. Gusset plates are fitted to the ends of "strong hold beams" for more securely connecting them with the hold beam stringer

plates. Sometimes used from margin plate to frames.

**Gusset stays.** Triangular plates fitted in some steam boilers for strengthening the connection of the end plates with the shell.

**Gutter angle bar.** The inner angle bar of a gutter waterway.

**Gutter, waterway.** The gutter or runway between the gunwale and gutter angle bars, forming a channel for water to run to deck scuppers.

**Half beams.** Short beams extending from a boiler or machinery casing or from the hatch side coaming to the side of the ship.

**Half-breadth plan.** The plan of one half of a vessel, divided by a center line drawn through stem and stern posts. It shows water, bow, and buttock lines.

**Half-breadth staff or rod.** A rod having marked upon it the half-length beams of a vessel. The measurements are taken from the half-breadth plan.

**Half floors, first buttocks.** Frames or timbers, the heels of which meet the middle line of the keel in wooden ships.

**Half hitch.** A bend in a rope; part of the process of making a knot.

**Half poop.** A deck of small height, from 3 to 4 feet only above the upper-deck; an after deck-house.

**Halliard, halyard.** A rope by which a yard, gaff, sail, flag, etc., is hoisted. They are named after the objects they are used to hoist.

**Hammock.** A bed used on vessels, made of canvas and hung up at each end by means of hooks.

**Hamper, tophamper.** The rigging and other necessary articles which encumber a ship aloft.

**Hand-hole** (in a boiler). A hole for cleaning purposes.

**Hand pumps.** Pumps worked by hand instead of by steam.

**Hand rails.** Metal bars or light pieces of wood, fitted on the sides of a ladder, as on that belonging to a poop, bridge, or forecastle.

**Handspike** A strong wooden bar used as a lever for turning a capstan, windlass, etc.; a bar for lifting heavy objects.

**Hand steering wheel.** A wheel used when steering by hand.

**Hand wheels.** Wheels for opening valves.

**Hanging knee.** A knee or support fastened under deck beams.

**Hanks.** Rings, of wood or iron, or catch hooks by which sails may be made to run on stays, or purchase ropes be hooked on to tackles.

**Harpings.** The thicker wales (planks) at the forward part of a hull and fastened to stern. (Sometimes spelled harpins.)

**Hatch, hatchway.** An opening in the deck of a vessel through which persons or cargo may descend. Hatches vary greatly in size and number, and are often

designated by numbers. See Plate XIV.

**Hatch battens.** Battens used for securing the edges of tarpaulins to the hatchway coamings, so that they cannot be torn off the hatches by wind or sea.

**Hatch covers.** Covers of wood or other material for closing up hatchways.

**Hatch bars.** Flat iron bars the full length of a hatchway, fitted close over hatches to prevent them from being opened by stealth.

**Hatchway end beam.** A beam placed at the fore or after end of a hatchway, to which the head ledge is connected.

**Hatchway carlings.** Plates, generally in the form of bulb plate, fitted under the hatchway coamings, between the hatch beams, and to which the inner ends of the half beams are fastened.

**Hatchway coaming.** The vertical plates forming the border round a hatchway. See Plate XIV.

**Hatchway house.** A structure fixed over a hatchway as a protection from rain, wash of the sea, etc.

**Hawse.** That portion of water in front of a ship which extends from the stem of the boat to the point which lies vertically above the anchor when down.

**Hawse blocks.** Plugs for stopping the hawse holes when the ship is at sea.

**Hawse flap.** An iron cover or shutter fitted on the outside of a hawse pipe, to prevent the sea entering through it.

**Hawse hole.** One of the holes in the upper bow near the stem, into which the hawse pipe is fitted.

**Hawse pipe.** A cast-iron pipe usually fitted in a hawse hole to prevent the chafing by the cables. In modern practice, made to house anchor. See Plate XIV.

**Hawse-pipe flange.** The rim on either end of a hawse pipe, fastened with bolts to the deck and shell plating of a vessel, to keep the pipe in position.

**Hawser.** A rope, manila hemp or wire, 90 to 100 fathoms long; less in size than a tow rope, but heavier than a warp.

**Hawser laid.** The designation of a rope laid (or wound up) in right-hand direction. It may be

**Plain laid,** with three or four strands, or

**Shroud laid,** with four or more strands laid about a heart or core strand.

When **Cable laid,** three or more strands of plain laid rope are laid up together with a left-hand twist.

**Hawser port.** An opening in the side plating of a forecastle, or in a bulwark, etc., for passing the hawsers through when used for towing or mooring a vessel.

**Head of a ship.** The fore end of her. "By the head," or "down by the head," implies that the

head is depressed, just as "down by the stern" signifies that her stern is down.

**Head knee or cheek knee.** The principal knee, or strengthening piece, fayed to the stem.

**Headledge.** The fore or after thwartships piece of a hatchway coaming.

**Headledge plate.** A plate forming a headledge.

**Headlights.** Lights carried at the masthead.

**Head of the mast, or masthead.** That part of the mast from the hounds upward.

**Head of the bowsprit.** The forward end.

**Head of a deadeye.** The outer side of the flat surface through which the holes are bored.

**Head of the keel.** The forefoot, the other extremity being the heel.

**Head sails.** The forward sails, as the jib and forestay sail.

**Heads.** The timbers (ribs) of a vessel, or the upper parts of them.

**Heater or heater boy.** A boy who heats rivets.

**Heating tongs.** Tongs used to take rivets from fire.

**Heave.** To throw or cast forth with a toss; as, to heave a line.

**Heel.** The inner end of a bowsprit or a jib-boom, also the lowermost portion of any mast.

**Heel brace.** The bottom rudder brace.

**Heel knee.** A knee sometimes fitted for more securely connecting the heel of a sternpost to the after end of a keel.

**Heel pintle.** The bottom rudder pintle.

**Heeling.** Careening or tipping over upon the ship's side.

**Helm.** The rudder, tiller, and other gear by which a vessel is steared.

**Hemp rope.** A rope made from the fibers of common hemp.

**High-pressure connecting rod.** The rod connecting the piston rod of high-pressure cylinder with the crankshaft.

**High-pressure cylinder.** The cylinder in a compound, a triple-expansion, or a quadruple-expansion engine, into which the steam first enters, and after its use there passing either into an intermediate or the low-pressure cylinder.

**High-pressure engine.** An engine to which steam is admitted at or above a boiler pressure of 5 atmospheres, equal to 75 pounds per square inch.

**High-pressure gear.** The mechanism attached to high-pressure cylinder.

**High-pressure piston.** A piston working in a high-pressure cylinder.

**High-pressure piston rod.** The rod connected with a high-pressure piston.

**High-pressure steam chest, high-pressure valve chest, high-pressure valve casing.** The casing in which the valve works to admit steam to H. P. cylinder.

**High-pressure valve casing door.** The door for high-pressure valve casing. See Plate XXXIX.

**High-pressure valve rod, high-pressure valve spindle.** The rod connecting a high-pressure valve with the link.

**Hinge.** A connection between two parts, such that one part will turn upon the other.

**Hitch.** Name given to a certain twist made with rope to form knots which may be very easily loosened.

**Hogged.** A vessel is said to be "hogged" when the fore and after ends of the hull have dropped with regard to the middle portion.

**Hogging.** A falling of the head and stern by some accidental weakness in the keel—a dangerous thing with a ship, sometimes the result of her taking, or remaining too long on, the ground.

**Hoist.** To elevate or to haul aloft with or without the assistance of tackles.

**Hoisting engine.** A steam winch or other machine used for hoisting cargo, ashes, etc.

**Hoisting gear, lifting gear.** Tackles, screws etc.; in an engine room, used for lifting cylinder covers, crankshafts and various other heavy parts of an engine.

**Hold.** The space below a vessel's deck, principally allotted for the reception of a vessel's cargo.

**Hold beam.** A beam fitted below the deck beams in one-decked vessels, and below the lower deck in vessels having several decks.

**Hold-beam stringer.** A stringer plate on the ends of hold and orlop beams. These stringers are usually between such beams supported by bracket plates, riveted to the frames.

**Hold bunker.** Term given to a coal bunker, or the portion of one, below the lower deck.

**Hold ceiling.** The covering of the inside of the frames, below the lower deck.

**Hold pillar.** A pillar supporting the lowermost deck.

**Hold stringer.** Any stringer fitted in the hold of a vessel.

**Holidays.** Portions of the surface of a vessel's side, or anything in connection with a ship, left bare through carelessness when painting or tarring.

**Hollow keel.** A range of plates fitted horizontally in fore-and-aft direction, under the floors, at the middle line of a vessel, forming a keel; the plates being so bent as to make a channel underneath the floors.

**Home.** Anything close up or in its place; the port a ship hails from.

**Hood.** A covering of canvas or sheet iron, etc., over a scuttle companion, or a steering gear.

**Hook stick.** A rig used to hold drilling machine for light drilling.

**Hooks.** Triangular plates fitted horizontally in the fore extremity of a vessel, for connecting the ends of the stringers and for strengthening this part.

**Horn, to.** To line up or square up.

**Horseshoe plate.** A small plate in the form of a horseshoe, fitted round the rudder stem, at the lower entrance of the helm port, to prevent the wash of the sea entering. See Plate XV.

**Horsing.** To drive oakum into the seams of a vessel's outside planking, by means of a horsing iron and a large wooden hammer.

**Horsing iron.** A broad, blunt, chisel-shaped tool, used with a wooden mallet to drive oakum into the seams of a vessel.

**Hotwell.** A casing or trough to receive the warm water condensed from the steam.

**Hound.** That portion of a mast upon which the trestletrees are lodged, and by which they are kept in the desired position.

**Hounding.** That portion of a lower mast between upper deck and the trestletrees; of a topmast cap and the topmast trestletrees; a bowsprit, that portion outside (forward) of the bed.

**Hounds.** Those projections at the lower part of a masthead which carry the trestletrees, shrouds, stays, etc.

**House coaming.** Strong vertical plates, or pieces of timber, forming a base of a deck house.

**House line.** A three-stranded cord, a little stouter than marline, used for like purposes.

**Housing.** That portion of a lower mast under the upper deck; that portion of a topmast beneath the lower mast cap; that portion of the bowsprit abaft the bed.

**Hulk.** The dismantled hull of an old vessel, often used as a coal depot, from whence steamers obtain fuel.

**Hull.** The keel, stem, sternpost, propeller post, keelsons, stringers, decks, outside and inside planking, or plating, etc., including also the frames, beams, decks, in- and outside planking or plating of poops, forecastles, etc., but exclusive of every equipment.

**Hydraulic ram.** A cylinder fitted with a plunger so as to use water pressure to start launching cradle if necessary. See Plate XXVI.

**I beam.** Iron beam with cross section like letter I.

**Ice lining.** Extra plates of iron fixed at the height of the water line on a vessel's bow as protection against ice.

**Inboard.** Within the ship.

**Incrustation.** A coat of salt, lime, or other matter adhering to the inside of boilers.

**Independent rudder pintles.** Pintles which are not forged to the

main piece, but fitted with a nut and screw, so as to be shipped and unshipped when desirable.

**Indicated horsepower.** The actual work done in the cylinder by the steam as shown by the indicator.

**Indicator.** An instrument by which the varying pressure in steam cylinders or pumps, the action of a slide valve, etc., are shown and recorded.

**Indicator card.** A card which receives in diagram form the record made by the indicator pencil.

**Indicator cock.** A cock by which steam from a cylinder is admitted to pass through the indicator pipe to the indicator.

**Indicator pipe.** A connection with the top and bottom of a steam cylinder leading steam from either end to an indicator. See Plate XXXIV.

**Inner bottom.** The top of a double bottom.

**Inner bottom plate.** One of the plates forming the top of a double bottom.

**Inner bottom plating.** The plates forming the top of a double bottom.

**Inner keel.** When a double keel is used, the inside one. See Plate VI.

**Inner skin.** The plating or planking covering the inside of the frames.

**Inner sternpost, inner post.** A piece of timber similar to the sternpost fitted on the inner side of the latter and bolted to it.

**Inner stringer angle bar.** Any angle bar on the inner part of a stringer plate.

**Inner waterway.** The inside of two strakes of timber fitted on a waterway.

**Inside strake.** A strake the edges of which are overlapped by those of the outside strakes.

**Intercostal floors.** Ranges of strong short plates fitted vertically (usually one at every second frame) between the various girders of a cellular double bottom.

**Intercostal girders.** A range of short plates fitted vertically and forming a girder between the floors of cellular double bottom having continuous floors.

**Intercostal girder angle bar.** A bar placed in a fore-and-aft direction to connect an intercostal girder plate in a cellular double bottom to the inner or outer bottom plating, or placed vertically for fixing it to a floor plate.

**Intercostal keelson.** A range of plates fitted vertically between the various floors, extending as far forward and aft as practicable. It may have its upper part connected to a bilge, side, or middle-line keelson, or the tank top, and its lower edge fastened to the outside plating by short fore-and-aft angle bars. In some vessels the ends of each are secured by vertical angle bars to the floors.

**Intercostal plates.** Short plates fitted vertically between the floors as intercostal keelsons, or horizontally between the frames to form an intercostal stringer; named after the keelsons or stringers which they form. See Plate XXII.

**Intercostal stringer.** A range of plates fitted horizontally between the frames, having its inner part connected to a bar stringer and its outer edge fastened to the outside plating by short angle bars extending from frame to frame.

**Intercostals.** Short plates set between other members and riveted to them, the plates being in line and forming one continuous member. See Plate III.

**Intermediate beams.** Beams placed between deck beams, if the spacing of the latter is unusually large.

**Intermediate connecting rod, intermediate-pressure cylinder connecting rod.** A rod connecting the piston rod of an intermediate-pressure cylinder with the crankshaft.

**Intermediate cylinder, intermediate-pressure cylinder.** The cylinder between the high- and low-pressure cylinders in a triple-expansion or quadruple-expansion engine.

**Intermediate cylinder cover.** The cover of intermediate cylinder. See Plate XXXIX.

**Intermediate frames.** Those frames in a cellular double bottom to which no floor plates are connected.

**Intermediate pinion.** The second pinion in a two-stage reduction gear. It is mounted on a shaft with the intermediate gear and drives the main gear. See Plate XLV.

**Intermediate piston rod.** The rod connected to an intermediate-pressure piston.

**Internal feed pipe.** A pipe leading from the feed valve to the interior of a boiler, for conveying feed water to a place where it is taken up by a volume of warmed water to prevent contact of cold water with the heated parts of the boiler.

**Internal steam pipe.** A perforated pipe, situated in the steam space of a boiler below the main steam valve, to separate any water raised with and held in suspension by the steam, which when so drained passes through the steam valve into the main steam pipe.

**Isherwood system.** See Appendix VI.

**Jack.** A name applied to various spars, sails, ropes, etc.

**Jack (in flags).** See Union Jack.

**Jackrod.** A pipe, rod, or rope to which awnings are laced.

**Jackstaff.** A flagstaff at the bow of a ship.

**Jacket gauge.** A gauge attached to the steam jacket of a cylinder, to ascertain the pressure of steam in same.

**Jacket steam pipe.** A branch pipe leading steam from the main pipe to the interior of a steam jacket.

**Jackstays.** Light iron bars passed through eyebolts, connected about every foot to the upper part of a yard, or on the back of a lower mast. To these stays the head ropes of sails are fastened.

**Jacob's ladder.** A flexible ladder made of rope; has wood rungs. See Plate LVII.

**Jam hammer.** A special type of holding-on hammer used in heavy riveting. See Plate LV.

**Jaw.** The crutch or hollowed semicircular projection on the inner end of a boom or gaff, loosely clasping a mast so as to permit of such boom or gaff being raised or lowered on the mast.

**Jet condenser.** See Condenser.

**Jetsam, jettison.** Portions of a vessel's cargo thrown overboard for the purpose of lightening.

**Jewel block.** A block fixed under a yardarm, through which a studding-sail halliard is rove.

**Jib.** A triangular sail carried on a stay extending from the foremast head or fore topmast to the jib-boom.

**Jigger.** A small spar or an extra mast. The fifth mast in a five-masted schooner is the jigger mast.

**Joggle.** To bend plates and frames to fit other work, without liners.

**Jogging, foggle.** To offset a plate or shape to save the use of liners.

**Joggled frame.** A frame offset to permit the shell plating or planking fitting tight to the frame without the use of liners.

**Jolly boat.** Name given to a ship's boat of small size, as a "dingy."

**Journal.** The portion of a shaft, axle, etc., which revolves in or upon some support, as a cross-head journal, lever journal.

**Jump.** To put two planks or plates of iron together in such a manner that they will present a smooth surface.

**Jury mast.** A temporary mast; one erected in a new vessel to take her where she is to be masted, or taking the place of a permanent mast carried away.

**Jury rudder.** A temporary or substitute rudder, or any apparatus used to steer a vessel in place of a rudder.

**Kedge, kedge anchor.** A small anchor carried by large vessels for use in shallow water, or for keeping the main anchor clear. It may be used for similar purposes as a stream anchor, the difference being that a stream anchor is used for heavy and a kedge for lighter operations.

**Keel.** The backbone of a vessel; in wooden ships, composed of great lengths of timber, connected to each other by scarphs; in steel

ships, generally a continuous range of plates from stem to stern.

**Keel, even; keel, uneven.** Terms used in expressing the manner in which a boat floats. If she balances evenly in a fore-and-aft direction, she is on an even keel; if depressed either by the head or the stern, she is on an uneven keel.

**Keel, bar.** A keel formed by a bar. The garboard strake is flanged and riveted to it and it usually extends below the line of bottom plating.

**Keel blocks.** Heavy blocks on which a ship rests during construction.

**Keel, docking.** See Bilge keel.

**Keel piece.** The piece of keel forming one forging with the sternpost of a sailing vessel, paddle, or twin-screw steamer, or forging with a stern frame, extending from the propeller post forward.

**Keel plate.** A plate forming part of a flat plate keel; also, the range of plates fitted at the middle line and extending fore and aft under the frames and floors, in a composite ship.

**Keel rabbet.** The groove on each side of the keel, into which the lower edge of the garboard strake is inserted (in wooden ships).

**Keel rivet.** A rivet driven through the lower part of the garboard strakes and the keel.

**Keel rope.** A rope running between the keelson and the keel of a ship, to clear the limber holes when they are choked up with ballast.

**Keel scarph.** Any scarph made, either vertically or horizontally, in a keel.

**Keelson** (in wood ships). A vertical addition to the keel inside the boat running the full length of the ship. It rests upon the keel and is an indispensable member, taking the stepping of the mast, and serves to secure the feet of the timbers on each side of it (in steel ships). A longitudinal member of the framing. It may be intercostal or continuous, flat or vertical. A center, side, or bilge keelson. Whatever its form or position, its purpose is always to give longitudinal strength. See Plate XIX.

**Keelson angle bar.** Any angle bar used in the construction of a keelson.

**Keelson casing.** A wooden envelope over the keelson to keep the salt in place, when a keelson has been salted to prevent dry-rot.

**Keelson plate.** A plate forming a part of any kind of plate keelsons.

**Keelson scarph.** The tapering of a part of the lap joint on keelson plates to allow the angles to run straight.

**Keelson, vertical.** A keelson built with plates set vertically.

**Kentledge.** Pig iron used as a permanent ballast in a vessel.

**King post.** A vertical post to support cargo booms.

**Kingston valve.** A valve of conical form having a threaded spindle, fitted against a vessel's side in communication with the sea, serving as "injection valve" or "blow-off valve," notably in wooden vessels.

**Kink.** A sharp bend in a rope, always dangerous, but more especially so in wire roping.

**Knee.** An angular piece of timber, usually a natural crook, used to strengthen corners; sometimes made of iron or steel.

**Knightheads.** The foremost frame timbers in a ship, one being placed on each side of the stem, and in many vessels extending above it. In steel sailing ships with cutwater stem, small triangular plates that serve as frames and support bowsprit.

**Knot.** A knotted mark on a log line; also designates the distance between any two marks in a common log line.

**Knot.** A nautical mile, 6,080.27 ft.

**Knuckle.** The line at the angle that divides the upper from the lower stern or counter of elliptical and round stern vessels. See Plate XV.

**Knuckle molding.** The molding that covers the knuckle line.

**Lacing.** A line by which a staysail is loosely attached to a stay so that it can be hoisted or lowered; also, a line rove through eyelet holes in a gaff sail, to replace "reef points" when reefing such a sail.

**Ladders.** Inclined or vertical steps are called ladders aboard ship, taking the place of stairs.

**Lagging.** Material used for covering boilers, etc., to prevent loss of heat by radiation. See Plate XXXVIII.

**Land.** The overlapping part of the planks in a clincher-built boat.

**Land boards.** Boards on deck near hatches to receive cargo and protect deck.

**Landing.** Distance from edge of plate or heel of an angle to center of rivet hole.

**Landing edges of plating.** The edges of plates overlapping the edges of other plates.

**Landing place.** A pier, wharf, or jetty where goods or passengers are landed.

**Lanyard.** A short piece of rope, rove through deadeyes, one fixed to the upper part of a chain plate, the other to the lower end of a shroud, backstay, etc., to connect them to each other.

**Lanyards.** Short pieces of rope, used to tighten up davit guys, boat lashing, awnings, etc.

**Lap.** The portion of a slide valve overlapping the steam port when the valve is at its half stroke.

**Lapped frames.** The connection of frame angle bars, by overlapping their ends.

**Lapped joints.** Joints in which the material laps over at the connection.

**Laps.** The distance that one plate lays over on another in a lap joint.

**Lapstrake.** The method of boat building called clincher building in which the strakes overlap. Same as clinker built.

**Launch, longboat.** The largest boat on board of a ship, usually having a square stern, used for bringing out anchors and chain cables, for assistance in floating a vessel when aground, and for provisions, etc.

**Launching.** The process of sliding a boat from the building berth into the water. See Plate XVII.

**Launching cradle.** The framework of timber on which the vessel rests when she is launched. See Plate XVI.

**Laying off.** Placing working directions on material, such as location of holes, lines, and the nature of the operation to be performed.

**Laying out.** A mold loft or drawing room operation, putting down lines on the floor or paper which show the shape of the ship's parts.

**Lazy guy.** A rope or tackle by which a boom is held down so that it may not swing about in rough weather.

**Lead.** A leaden weight attached to the end of a line and used to ascertain the depth of water beneath a vessel and the nature of the soil.

**Leadfair.** Any ring or block or hole which leads a rope in the direction required.

**Leak.** Any split, hole, or fissure in the hull of a vessel which allows water to enter.

**Ledge bars.** Bars used to support the hatch covers.

**Lee side.** The side opposite to that against which the wind blows.

**Leeway.** The deviation of a vessel from her steered course, caused by the action of the wind and waves.

**Length over all.** The entire length of the ship from stem to stern.

**Length** (of a vessel). The distance from the fore side of the stem to the after side of the sternpost, over or in a line with the upper deck.

**Length of chain cable.** The portion of chain between two joining shackles, usually 15 fathoms.

**Lengthening** (of a ship). The vessel is cut through at her half length; the two portions are next separated the required distance from each other, and the intervening space is then fitted up with frames, plating, or planking, etc., properly uniting the former halves of the vessel.

**Levee.** The embankment along a river side, constructed to pre-

vent inundation of the adjacent land.

**Lever.** A bar of metal or other substance turning freely on a support called the fulcrum or prop. Used to impart pressure or motion from a source of power to a resistance.

**Lewis bolts.** A maze-shaped bolt fastened in a socket by pouring in melted lead.

**Life buoy.** An apparatus sufficiently buoyant to support a person in the water.

**Lift, to** (v.). To make a template on a ship or from some part of a ship by fitting it to the place where the shape or plate the template is for is going to be placed.

**Lifts.** Ropes extending from a masthead to the yardarms serving as a support.

**Lifting gear, hoisting gear.** Tackles, screws, etc., employed in an engine room, for lifting cylinder cover, crankshafts, and various other heavy parts of the engine. See Plate XLI.

**Lightening.** To lighten a vessel by discharging into lighters, etc., some of the cargo for the purpose of lessening her draft.

**Lightening holes.** Holes cut in plates to reduce weight and to provide means of access. See Plate XX.

**Lighter.** A large-sized craft, used for the purpose of lightening a vessel, when grounded, or for bringing cargo alongside.

**Light screens, side-light screens.** Two open casings of wood or iron placed one on each side to hold the sidelights and so placed that the lights are not seen across the bow.

**Light water line.** The line of immersion, when a ship is light; i.e., when having no cargo or ballast on board.

**Limber chain, limber clearer.** A chain rove through the limber holes. By moving it from time to time it prevents the watercourse getting choked.

**Limber holes.** The apertures for the passage of water in floors.

**Limbers, watercourses.** In wooden vessels, gutters or channels upon the floors, one on each side of the keelson.

**Limber strake.** The strake of inside planking nearest to the keelson.

**Linchpin.** A small iron pin passing through some shaft, axle, or bar, such as the stock of an anchor, sometimes called a forelock.

**Line.** Thin cord, as a marline, a log line, lead line, ratline, etc.

**Liner, lining piece.** A piece of metal used as a filling piece, called by structural steel workers a filler. See Plate LIX.

**Liners.** Short bars filling spaces between plates and shapes.

**Lines** (on a drawing) Principal lines of a drawing are as follows:

**A. Base line.** A horizontal reference line from which

vertical measurements are taken.

B. **Buttock line.** A vertical line on the body plan parallel with the center line; a horizontal line in the half-breadth plan parallel to the center line; a curved line in the sheer plan.

C. **Center line.** A vertical line in the center of the body plan perpendicular to the base line; a horizontal line in the half-breadth plan through the center of the ship.

D. **Diagonals.** Lines running diagonally from center line to frame lines.

E. **Frame lines.** Outlines showing shape of frame of vessel.

F. **Water lines.** Horizontal lines parallel to the base line in the body plan; horizontal lines parallel to the base line in the sheer plan; curved lines in the half-breadth plan.

**Lines** (on a ship). Wires, cords, or chalk lines from which measurements are taken.

A. **Center line.** A line running fore and aft dividing the ship into two equal parts.

B. **Base line.** A reference line for vertical measurements at right angles to vertical center lines.

C. **Grade line.** A reference line established on a fixed slope or level.

D. **Check line.** An auxiliary reference line.

**Linesman.** A skilled loftsman who does especially difficult work.

**Lines plan.** A drawing showing general outline or form of the ship. The lines plan comprises these plans:

A. **Sheer plan.** A side view showing length of ship and heights of parts from keel.

B. **Half-breadth plan.** A top view showing a horizontal or floor plan on any water line.

C. **Body plan.** An end view showing curves of the sides or frame lines at any point in the ship. Frame lines forward of midships section are on the right of the center line; aft of midships section, on the left of center line.

**Lining.** The boards by which frames, deck beams, etc., in cabins, crew spaces, messrooms, etc., are covered or lined.

**Link.** Any intermediate piece of machinery receiving and transmitting power from one part of an engine to another.

**Link block, die.** A short piece of metal in connection with a valve rod, and sliding in a slot link.

**Link brasses.** Brasses fitted to the top and bottom ends of links.

**Link motion.** A contrivance, consisting of the eccentric sheaves and rods and a link, in communication with the slide valve

rod, to reverse the motion of an engine or cut off steam at any desired point.

**Lip of a scarph.** The shaped end of a piece of timber required for a scarph.

**List.** When one side of a vessel lies deeper in the water than the opposite side, caused by the shifting of cargo, etc.

**Lizard.** An iron ring spliced into a rope end, usually called a thimble or eye.

**Load line.** The surface line of the water along a vessel's side when fully laden.

**Lock bolts.** Bolts or studs, by which a guard ring, etc., is secured.

**Lock chambers.** The span enclosed by the sides and gates of a canal.

**Locker.** A closet, cupboard, or any small room built for storing tools, supplies, etc.

**Loft.** See Mold loft.

**Loftsman.** A man who lays out and makes molds for a ship.

**Log.** The apparatus by means of which the speed of a vessel is ascertained.

**Longitudinal.** Parallel to the keel, fore and aft. A bulkhead, frame, or stiffener, etc., is so called when it runs fore and aft.

**Long splice** The union of ends of rope when the strands are separated and laid together for a long distance.

**Lookout bridge.** An elevation above an upper deck, serving as a standing place for the lookout man

**Lower deck.** The second deck from above in two-deck vessels and the third from above in all ships having three or four decks.

**Lower rigging.** The rigging of the lower masts and their yards.

**Low-pressure boiler.** A boiler adapted for steam pressure not exceeding 90 pounds per square inch.

**Lugpad.** A plate with a projecting lug, the lug having a hole adapted for receiving the hook of a lead block, etc. The plate may be riveted to deck or shell plating, etc.

**Lugsail.** A triangular sail used in boats and other small craft.

**Main beam.** The beam placed at the greatest breadth of a ship.

**Main bearing.** A bearing for the main line shaft.

**Main bearing brasses.** The brasses in which the main shaft works.

**Main bearing journals.** Journals turned up on main shafting to take main bearings.

**Main body.** The hull, exclusive of any erection upon it, such as a bridge house, forecastle, poop, etc.

**Main body frames, main frames.** Frames below the main deck of a vessel. In vessels with three or more decks it is not the practice to keep the side framing as heavy above the second deck as it is necessary to be below.

**Main bulwark.** The bulwark fitted round the upper deck, or weather deck.

**Main check valve.** A valve, usually fitted on the back end plate of a boiler, to regulate the passage of feed water supplied by the feed pump.

**Main deck.** The principal strength deck in a ship. In two-deck vessels the upper deck is usually the main deck; in ships having more than two decks, it is the deck at the end of the full frames.

**Main deck sheerstrake, main sheerstrake.** The strake of outside plating level with the main deck.

**Main deck stringer angle bar.** Any angle bar connecting the said stringer with the main sheerstrake or with the frames.

**Main deck stringer inner angle bar.** An angle bar forming inner side of waterway.

**Main deck stringer outer angle bar.** An angle bar connecting main deck stringer to shell plating.

**Main deck waterway.** The channel along the edge of the main deck to lead water to the scuppers.

**Main engine.** The engine that propels a vessel; i.e., in distinction to auxiliary engine.

**Main exhaust.** The steam connection from engine to atmosphere.

**Main feed pipe.** The pipe leading water supplied by the feed pump from the hotwell to the boilers.

**Main floor.** The one placed at the greatest breadth of the ship.

**Main frame.** The one placed at the greatest breadth of the ship.

**Main hold.** The largest lower cargo compartment in a steamer.

**Main keel.** The upper range of pieces when the keel is constructed of two heights of timber.

**Main keelson, middle line keelson, center line keelson.** The principal keelson in a ship, and placed at the center line.

**Mainmast.** The principal mast of a vessel; the second mast counting from the bow to the stern.

**Main rail.** The one fitted on the upper edge of the bulwark plating, or upon stanchions surrounding an upper deck, if no bulwark plating is used.

**Mainsail.** The principal sail to the mainmast.

**Main shrouds.** Shrouds supporting the mainmast.

**Main topgallant mast.** The mast next above the mainmast on a square-rigged vessel.

**Main topmast.** A mast next above the main topgallant mast on a vessel square rigged, while on a fore-and-aft rigged vessel it is the mast next above the mainmast.

**Manhole.** A round or oval aperture in the top of a double bottom or a water ballast tank,

also in the girders of double bottoms, steam boilers, etc., to give access for the inspection, etc., of such reservoirs.

**Manhole cover, manhole door.** A lid by which a manhole is closed.

**Manger plate.** A plate set on edge on a deck so as to throw water to the side. On trawlers a series of such plates form bins to hold fish. See Plate XIV.

**Manila.** A valuable cordage made in the Philippines, which not being subject to rot does not have to be tarred.

**Manila rope.** Rope made from the fibers of plants growing in the Philippines.

**Man-of-war.** A vessel of the first class belonging to a navy.

**Margin bracket.** A bracket joining margin plate to side frames. See Plate XXIV.

**Margin plank.** A plank forming a boundary, as the deck plank nearest a waterway.

**Margin plate.** A plate joining tank top to shell plating. See Plates IX and XXII.

**Marine engine.** An engine especially designed for propelling vessels.

**Marker.** A brass pipe dipped in paint for marking rivet holes.

**Marking hammer.** A tool for marking rivet holes on a template with paint.

**Marline.** Thin line about ⅛ inch in diameter, made up of two fine yarns twisted together, used as serving round boltropes, etc.

**Marline hitch.** A hitch or knot made by riggers, for hauling small lines tight. See Plate LVI.

**Marling.** To wind any small line, as marline, spunline, etc., round a rope in such a manner that every turn it takes is secured by a sort of knot.

**Marling spike.** A short round bar of iron or wood, pointed at one end, used in splicing ropes, putting on sizing, etc. See Plate XXXVI.

**Marry.** To join one rope to another in such a manner that the joint may be received through a block (splicing rope).

**Martingale.** The rope extending from a jib-boom end downwards to a dolphin striker, to stay the jib-boom in the same manner as the bobstays stay bowsprit.

**Mast.** A long piece, or system of pieces, of timber placed nearly perpendicularly to the keelson of a vessel to support the spars, and gear, by which the sails are set. In modern practice, steel masts are built by riveting rolled plates together.

**Mast plate.** A plate used in the construction of an iron or steel mast.

**Mast partner plate.** A plate round a masthole, forming a mast partner, or a portion of one.

**Mast room.** The space round a mast between the mast beams.

**Mast rope.** A rope used for sending up and down a topmast, topgallant mast or royal mast.

**Mast trunk, tabernacle.** A well for a mast that is taken down frequently, as on boats passing under low bridges.

**Mast wedges.** Wedges driven around a mast in a masthole, to tighten a mast in a deck.

**Maul.** A large iron hammer.

**Matthew Walker's knot.** A stopper knot. It is formed by a half hitch on each strand.

**Measurement.** The ascertaining of the cubical capacity of a vessel, or any of her compartments or superstructures.

**Medium-pressure boiler.** A boiler of suitable strength for a pressure of steam, say, from 45 to 75 pounds per square inch.

**Medium-pressure engine.** An engine working with a steam pressure between 3 and 5 atmospheres, say, from 45 to 75 pounds per square inch.

**Messenger.** A rope or chain used for heaving a chain cable inboard; a rope for connecting halliards, sheets, etc., to a winch.

**Messenger wheels.** Wheels for the use of a messenger, fitted one to a windlass and the other to a steam winch.

**Metacenter.** That point in a floating body upon the position of which the stability of the body depends.

**Metallic packing.** Metal rings used as packing in cylinders, stuffing boxes, etc.

**Metallic piston.** A piston having metallic packing.

**Middle line.** A term used instead of center line in speaking of bulkheads, keelsons, etc.

**Middle line pillar.** Any deck or hold pillar fitted at the half breadth of a vessel.

**Midship deep tank.** A deep tank fitted about midway between the stem and sternpost.

**Midship floor.** The floor fitted at the half length of a vessel.

**Midship frame.** The frame at the half length of a vessel.

**Midships.** The middle portion of a vessel.

**Midship section.** The surface presented to view by a vesesl if cut through the middle transversely.

**Miter wheel.** See Bevel wheel.

**Mixed steam.** The blending of saturated steam with superheated steam; the result being saturated steam so far dried that only a slight trace of water remains.

**Mizzen mast.** The third mast in any vessel having three or more masts.

**Mizzen sails.** The sails carried on a mizzen mast.

**Mizzen shrouds.** The shrouds on a mizzen mast.

**Mizzen staysail.** The sail between the main and mizzen masts.

**Mizzen topgallant mast.** The mast above the mizzen mast on a square-rigged ship.

**Mizzen topgallant staysail.** The staysail between the main and mizzen topgallant mast.

**Mizzen topmast.** The mast next above the mizzen mast when it is rigged fore and aft.

**Mold.** To draw out in their proper dimensions the several parts of a ship, for the guidance of the builder.

**Molded breadth.** The breadth from outside to outside of the frames, i.e., exclusive of the outside planking or plating.

**Molded depth.** The depth, measured amidships, from the top of the keel to the top of the upper deck beams, less the "round of beam."

**Mold loft.** A room with a floor large enough to permit the drawing to full scale of the lines of a ship. See Plate LII.

**Molding.** Battens and sculpture of wood or metal, used for fashioning or ornamenting.

**Molding of a beam.** The beam's perpendicular dimension.

**Molding of a floor.** The depth of a floor; in small vessels, from 10 to 12 inches; in very large ships, from 3 to 4 ft., or more.

**Molding of a frame.** The measurement, in inches, athwartships.

**Molding of a keel.** The perpendicular measurement of a keel.

**Molding of a keelson.** The depth of a keelson.

**Molding of a stem.** The fore-and-aft dimension.

**Molding of a sternpost.** The dimension, fore and aft.

**Monkey forecastle.** A forecastle of small height and length, the deck being used for the placing and securing of the bower anchors, when inboard.

**Monkey gaff.** A gaff of small size extended from the mizzen topmast crosstrees, etc., and used for hoisting the ensign on.

**Monkey rail, topgallant rail.** A rail fitted on topgallant bulwark stanchions above a main rail.

**Mooring.** To make a vessel stationary by anchoring if in a bay or river; if alongside a quay or wharf, by fastening her with chains or hawsers.

**Mooring bitts.** The bitts to which cables or chains are attached in mooring a vessel.

**Mooring pipe.** A round or oval opening in the bulwark of a vessel, framed with a cast-iron rim or collar, used for passing the mooring chains through.

**Moorings.** The chains, hawsers, warps, etc., by which a vessel is moored.

**Mountings.** The fittings on anything, for instance, "boiler-mounting"; comprises all the valves, cocks, gauges, etc., on a boiler.

**Mouse a hook, to.** To pass a yarn or wire round a hook to prevent it from clearing itself of whatever it may be fastened to. See Plate LVII.

**Movable pillar.** A pillar which can be easily shifted.

**Movable propeller blades.** Blades bolted to a propeller boss so they may be renewed.

**Mudbox.** A cast-iron box with a perforated plate, usually just below the engine room platform, serving to prevent dirt, ashes, etc., entering the suction pipe of a pump.

**Mudhole.** An opening through which to discharge mud from the bottom of a boiler.

**Muntz metal.** A yellow metal alloy, 3 parts copper, 2 of zinc, malleable when hot; cheaper and can be more easily welded than copper.

**Mushroom ventilator.** A short cast-iron tube having a movable iron rod passing through its center. On top of the rod is fixed a round metal cup, which may be lifted to admit air or closed to prevent water entering the tube, usually fitted over cabins.

**Mushroom anchor.** An anchor with a saucer-shaped head; needs no beam, and has great holding power on soft bottoms.

**Nautical mile.** The 60th part of an equatorial degree, equal to about 6,080 English feet; therefore 6 nautical miles represent 7 English miles, approximately.

**Naval architecture.** The science of designing vessels.

**Naval hoods, hawse bolters.** Large pieces of thick timber above and below the hawse holes.

**Navigation bridge.** The bridge used for taking observations, or handling the ship in the more difficult situations. See Plate XVIII.

**Neap tides.** The lowest tides, taking place about 5 or 6 days before the new moon and full moon.

**Netting.** Nets of rope, placed at various parts of the ship, either for stowage or for protection against danger.

**Net tonnage.** The exact tonnage available for cargo after deducting for stores and supplies.

**New measurement.** The new rules for measuring the capacity of a vessel's interior. The customs authorities of nearly all nations allow 100 cubic feet, English, to equal one ton. The old rules used 40 cubic feet as equal to a ton.

**Non-condensing engine.** Any steam engine in which the steam, after its use in the cylinders, passes directly into the atmosphere.

**Non-return valve.** Any self-acting valve admitting the entry of water, etc., but preventing its outflow, or *vice versa*.

**Nut of propeller shaft.** A nut fitted on the extreme after end of a propeller shaft to prevent the propeller starting on the shaft.

**Nuts of propeller studs.** Nuts fitted on the studs inserted in a propeller boss, by which the flanges of movable propeller blades are securely fixed.

**Oakum.** The substance to which old ropes are reduced when un-

picked; used in caulking the seams of boats, stopping leaks, etc.

**Oars.** Long light spars shaped at one end to form a blade, and on the other to form a handle, used in propelling a boat by hand.

**Offset.** See Joggle.

**Oil box, oil cup.** A receptacle on a bearing, etc., for supplying oil to working parts.

**Oil cock.** A cock of small size attached to a lubricator, for delivering oil to a cylinder.

**Oil line.** Pipes for lubricating oil. See Plate XLV.

**Oil lubricating pipe.** A small pipe leading from a lubricator to supply oil to some working part of an engine.

**Oil manifold.** A manifold located in oiling system. See Plate XLV.

**Oil service pump.** A pump to circulate lubricating oil. See Plate XL.

**Oil service tank.** A tank to supply lubricating oil. See Plate XL.

**Oiltight.** Packed or caulked to prevent flow or waste of oil.

**Old man.** A form of heavy drilling rig.

**Old measurement.** The rule formerly employed in England, till superseded by the new rule, for ascertaining the cubical capacity of a vessel's interior. (Forty cubic feet equal a ton.)

**On board.** On or in a ship.

**On deck.** On the upper deck; "on hand," "on duty," "on the job."

**Open bridge house.** A bridge house not enclosed by bulkheads at each end.

**Orlop beams.** Hold beams fitted below the lower deck beams in ships having three complete decks.

**Orlop beam stringer, orlop beam plate.** A stringer plate on orlop beams.

**Orlop deck.** The lowermost deck in a ship having four decks.

**Orlop deck beams.** The lowermost tier of deck beams in any ship having four complete decks.

**Orlop stringer.** A range of plates fitted horizontally about midway between the lower deck and the bilge.

**Orlop stringer angle bar.** An angle bar connecting an orolp stringer plate either to the outside plating or to the frames, or fitted on its inner edge for extra strength.

**Outer bearing.** The bearing on a sponson beam, upon which the outer end of a paddle shaft revolves.

**Outboard.** Outside the hull, or beyond the gunwale; as, a bowsprit runs outboard.

**Outer bottom.** That portion of the shell plating of a vessel forming the bottom. See Plate VIII.

**Outer skin.** The outside plating or planking of a vessel.

**Outer stringer angle bar.** Short angle bars fitted between the frames, to connect the outer edge of a stringer plate to the

outside plating; named after the stringers to which they are fitted.

**Outlet cock.** Any cock used to allow the outward flow of water to free any receptacle, as a condenser, etc.

**Outriggers.** Strong battens bolted upon topmast or topgallant crosstrees, for giving greater spread to topgallant and royal backstays.

**Outside plating.** See Shell plating.

**Outside strake, overlapping strake.** A strake of plating which overlaps inside strakes with its upper and lower edges.

**Overhaul.** To examine or inspect. One vessel is said to overhaul another when gaining on her in speed.

**To overhaul a tackle.** To pull the blocks further apart, giving slack to the hauling part of the fall.

**Overflow pipe.** A pipe through which any excess of water, oil, etc., is carried off.

**Overhang.** The amount of a ship's hull projecting above and beyond a perpendicular from the water line at stem or stern.

**Overlap of plating.** That portion of a strake of shell plating, etc., covering that of another strake, generally regulated by the diameter of the rivets used to connect them. If single riveted, the overlap is usually 3½ to 4 times, and if double riveted, 6 to 7 times their diameter.

**Oxter plate.** A sharp curved plate under the counter of a vessel. It joins plating on sternpost to plating on cant frame.

**Oxy-hydrogen torch.** A cutting or welding torch using oxy-hydrogen gas. See Appendix. See Plates XLVI and XLVII.

**Packing.** Any material, as hemp, rubber, metal, felt, asbestos, etc., by which a steam, air, or watertight contact between two surfaces of metal is effected.

**Packing ring.** Packing in the form of a ring; a metallic ring which fits against the packing and inside the gland to compress the packing.

**Packing screw.** A tool used for drawing out "packing" when required to be renewed.

**Packing stick** A specially shaped hardwood stick used to force packing into the gland.

**Pad or pad piece.** A piece of timber laid upon the beams of a vessel to form the lateral curve (or camber) in the form of the deck.

**Pad eye.** An eye located on deck for fastening cables. See Lug-pad.

**Paddle beams.** The thwartships supports of a paddle box, upon the ends of which the sponson beam rests, and between which the wheels of a paddle steamer revolve.

**Paddle box.** A structure (generally half circular) on the topside of a paddle steamer, cover-

ing the upper portion of the paddle wheels.

**Paddle box bridge.** A platform extending athwartships from one paddle box to the other.

**Paddle box cabin.** The prolongation of a paddle box, containing a room or rooms for dwelling.

**Paddle box framing.** The trussing or framing of the paddle box to which the boards or plating forming the cover of the paddle box are fastened.

**Paddle box stays.** Supports extending diagonally, from beneath the spur beams, etc., to the vessel's side.

**Paddle shaft.** The axle on which the wheel of a paddle steamer is fixed.

**Paddle float.** The wooden blades in the iron arms of the paddle wheel.

**Paddle steamer.** A steamer driven by means of paddle wheels fitted one on each side of the vessel.

**Paddle wheel.** Wheels fitted (one on each side) of a paddle steamer in connection with the paddle shaft, consisting of a cast-iron "boss" from which wrought-iron arms radiate strengthened by "rims" and "stays"; a "float" being attached to each arm.

**Painter.** See Boat's painter.

**Pall or pawl.** A small metal finger-like piece that is so pivoted on a winch or capstan as to prevent the revolving part from turning backwards on account of the load.

**Palm.** A leather strap, to fasten round the hand of a sailmaker, having at the palm a small, round steel plate indented like a thimble, to force the sail needle through the canvas; a flat face or flange on the top end of sternpost and rudder post to which stern framing is riveted. See Plate XXVII.

**Palm of anchor.** The part of an anchor which catches on the bottom and holds.

**Panhead rivet.** A rivet with a pan-shaped head.

**Panting** (of a vessel). The vibratory motion of the frames and plating or planking from outwards inwards, and *vice versa.*

**Panting bar.** A bar placed to prevent panting.

**Panting beams.** Beams fitted to a deck in the fore and after ends of a vessel, to prevent "panting." See Plate X.

**Parbuckle.** A method of lifting a cask or some other heavy object by doubling a rope into two legs, passing them under the object, and hauling on both together.

**Parceling.** Long narrow strips of tarred canvas wound spirally round a rope, and principally used under the serving.

**Parrel.** Any apparatus which keeps a yard to its mast.

**Parrel rope.** A rope which keeps a yard to a mast. Wooden balls prevent jamming.

**Part double bottom.** A vessel is considered "part double bottom" if the "wing girder" or "margin plate" does not extend from end to end of the ship.

**Partial bulkhead.** A term given to a thwartships bulkhead that extends only a short distance from either side of the vessel, or to a bulkhead not extended up to the main deck.

**Partial iron deck, partial steel deck.** When only a partial iron or steel deck is laid, it is usually fitted amidships under a complete wooden deck for extra strength; extending from side to side and for one-half to three-fifths of the vessel's length.

**Passer.** A man who passes rivets to the holder-on or puts them in the rivet holes.

**Passing tongs.** Tongs used in passing a rivet.

**Patient slip, slipway.** An inclined plane up the slope of which a vessel is hauled, by heavy tackle, capstans or steam power, for cleaning and painting the bottom or for repairs. The slipway forms a substitute for a drydock.

**Patent windlass.** See Windlass and Steam windlass.

**Pawl.** A small stop or catch, which prevents a moving object from going beyond a certain limit. See Pall.

**Pay off, to.** Paying the ship's crew the money due each one at the expiration of the voyage.

**Paying of seams in planking.** The filling of seams with pitch after caulking.

**Pay out, to.** To pay out a cable or hawser means to slacken it more and more away.

**Pea of an anchor.** The bill, or sharp-pointed end, of the fluke.

**Peak.** The upper end of a gaff.

**Peak purchase.** A tackle, a purchase applied to the peak halliards to swing them up taut.

**Peak bulkhead.** A bulkhead separating a peak from the hold, usually the collision bulkhead. See Plates IX, XXIII and XXV.

**Peak, fore or stern.** The sharply narrowed portion of the hull or hold at the bow or the stern.

**Peak tank.** A tank fitted in the extreme (lower) fore or after end of a steamer.

**Pendant or pennant.** A long pointed flag, usually a signal.

**Pet cock.** A small cock fitted on a bilge pump, feed pump, etc., to ascertain their proper workings.

**Pet valve.** A valve of small size, fitted to a pump, allowing the passage of a little air inward to soften the shock of the delivery, and to ascertain the proper working condition of the pump.

**Pier.** A structure of iron or wood, built out into a sea or river, for the landing of passengers and goods.

**Pig iron.** Crude cast iron.

**Pile.** A piece of timber or iron, driven, with others, into the ground or into the bed of a

river, for the support of a pier, bridge, etc.

**Pillar.** Any iron or steel bar, fitted vertically, to support a deck, or any other part of a ship's structure. See Plate XXVI.

**Pillar ladder.** Pillars fitted with rungs to form a ladder, usually extending from the headledge of an upper deck hatchway down to the keelson, or to the top of a double bottom.

**Pillow.** A block of timber whereon the inner end of some spar, such as the bowsprit, is rested.

**Pilot bridge.** A narrow thwartships platform, extending from side to side above a steamer's upper or bridge deck, to serve as a station for the pilot, commander, or officer of the watch.

**Pilot house.** A house located and fitted for navigation purposes, usually forward and always above other superstructures. See Plates XVIII and XXXIII.

**Pin rails.** Rails fixed inside of the bulwarks or immediately above the deadeyes or screws of lower rigging in wake of the various masts, and fitted with belaying pins for belaying the running gear.

**Pintles.** The pins on a rudder which fit into the gudgeons, or eyes, on the sternpost of the boat.

**Pintles.** Bolts used for securing the rudder to the stern frames.

**Pintle scores, gulleting of a rudder.** The cuts on the fore side of a rudder, below and behind the pintles, so as to allow a rudder to be shipped and unshipped.

**Piston.** A cast-iron disc, fitting closely the interior of a cylinder, and to which a "to and fro motion" is given by the steam through the ports. See Plate XXXIV.

**Piston expansion valve.** A valve, similar in construction to the piston valve, for the purpose of "cutting off" steam from entering the cylinder before the piston rod has completed its stroke; the portion of steam admitted finishing the stroke by expansion.

**Piston guide or tail rod.** An extension of piston rod through cylinder head.

**Piston rings.** Rings fitted to prevent steam leakage between piston and cylinder walls.

**Piston ring studs and nuts.** Studs and nuts that hold piston springs in place.

**Piston rod.** The part which transmits pressure exerted on piston to crosshead. See Plates XXXIV and XXXIV-A.

**Piston rod crosshead.** A block forming the jointed connection between a piston rod and a connecting rod.

**Piston spring.** Spiral and other forms of springs, inserted between a piston flange and a junkring, serving to press the packing rings closely against the inside surface of the cylin-

der to prevent the passage of steam.

**Piston rod nut.** A nut holding piston on piston rod.

**Piston valve.** A valve of circular form acting in a perforated chamber and employed in place of an ordinary slide valve, having the advantage over the latter that it works with less friction and requires less power for its motion than a sliding valve. See Plate XXXIV-A.

**Pitch.** The distance betwen the center of two contiguous objects, as between the centers of two adjacent rivets, teeth of a wheel, etc.; also, the distance a screw propeller would advance in one revolution, if turning in a steadfast medium.

**Pitch chain.** A chain transmitting motion from one sprocket wheel to another.

**Pitch of a propeller.** See Pitch.

**Pitching.** The alternate up and down motion of a vessel with her fore end on the crest and in the hollows of a turbulent sea; a vessel's motion in a plane nearly parallel to her keel.

**Pitting.** The eating of numerous small hollows in the parts of iron and steel machinery through corrosion.

**Planking.** The covering of the ribs of a hull with planks disposed in strakes; in other words, the skin of the ship.

**Plate.** Iron or steel rolled to an equal thickness, or metal castings of a plate form but not necessarily of uniform thickness.

**Plate keel.** See Keel.

**Plate knee, knee plate.** See Bracket plate.

**Plates, diagonal.** Plates fitted diagonally under deck planking.

**Platform.** Plating or boards, joined horizontally, forming an elevated stand or flooring.

**Plating.** All of the plates used for covering frames, beams, etc., in any part of a ship.

**Play.** The difference between the diameter of a shaft, rod, etc., and that of the aperture in which it works.

**Plastering trowel.** A flat oblong trowel rectangular in shape.

**Plimsol mark.** A mark to indicate the load water line for fresh and salt water, and for summer and winter.

**Plummer blocks.** Cast-iron or steel blocks (resting on pedestals, in a shaft tunnel) in the bed of which the tunnel shafting rests or revolves.

**Plying hammer.** A form of hand-riveting hammer.

**Pocket bunker, pocket coal bunker.** A space, smaller than a usual bunker, in which coal is kept for ready use.

**Pointing trowel.** A triangular trowel used by bricklayers.

**Pole.** A rod used for pushing a boat along.

**Pole of a mast.** The upper end of the highest mast; the part which rises above the rigging.

**Pole mast.** A mast complete in itself, that is, without the addition of a topmast.

**Pontoon.** A portable boat. A number placed together sometimes may carry a bridge.

**Poop.** A structure on the after end of an upper deck extending from side to side of a vessel, the interior generally arranged as a cabin.

**Poop bulkhead.** A bulkhead placed at the fore end of a poop between the upper deck and the poop deck.

**Poop deck beams.** The beams on which a poop deck is laid.

**Poop deck waterway.** The space between the gunwale and the gutter angle bars on a poop.

**Poop ladder.** A ladder leading from an upper deck to a poop deck.

**Poop rail.** A rail surrounding the deck of a poop.

**Poop sheerstrake.** The uppermost strake of plating on the outside of the poop frames.

**Pooped.** When a wave has entered over the stern of a vessel with damage resulting.

**Port.** An opening in a vessel's side, in a bulwark, etc., used for various purposes. See Plate XV.

**Port flap.** The hinged plates or framework closing a port.

**Port flap hinge.** The joint or flap by which it is hung.

**Port frame.** A reinforcement placed around a port, generally of angle bar.

**Port, helm** (rudder port). The hole through which the head and stock of a rudder (or helm) passes when the vessel has a counter.

**Portholes.** Openings in the side of a vessel, as the round holes or windows seen in passenger steamboats. See Plate XV.

**Port lid.** The lid which shuts a porthole.

**Port side.** The side of ship on the left hand when facing forward.

**Port sills.** The planks of timber which lie horizontally in the framing of a porthole, top and bottom, like window sills.

**Ports, steam.** Passageways in a slide valve or piston valve by which steam passes in or out. See Plate XXXIV.

**Pouches.** Strong bulkheads placed across the hold to prevent the cargo from shifting in vessels that are laden in bulk.

**Preventer.** An additional rope supporting another when that one is subject to unusual strain.

**Preventer bolts.** Bolts in the preventer plates of large vessels.

**Preventer plates.** Broad plates of iron below the chains in large sailing ships.

**Preventer stay, or preventer backstay.** In fore-and-aft craft, a backstay easily slackened when the mainsail swings over; sometimes called runners.

**Pricker.** A kind of small marlingspike, used to enlarge eyelet holes in sails, etc.

**Profile plan.** Side elevation of a ship's form.

**Profile draught.** A name applied to two drawings from the sheer draught, one represents the entire construction and disposition of the ship, the other her whole interior work and fittings.

**Proof-strain.** A limited test applied to anchors, chains, etc., to prove the trustworthiness of the material from which they were manufactured.

**Propeller.** The means by which a vessel is driven through the water; usually applied to "screw propeller" of a screw steamer.

**Propeller blade flange.** A flange on blades that are bolted to propeller boss.

**Propeller blades.** The flat arms that take hold on the water as propeller turns.

**Propeller boss.** The hub to which removable blades are bolted. See Plate XXV.

**Propeller bracket, propeller strut.** A frame supporting bearing for shaft outside of regular stern framing. See Plate XV.

**Propeller frame.** See Stern frame.

**Propeller post.** See Screw post. See Plate XXVII.

**Propeller, screw.** A propeller so called because blades are at an angle to line of axis, similar to the thread of a screw. See Plate XXV.

**Propeller shaft, tail shaft.** The shaft to which the propeller is keyed or fastened.

**Propeller shaft boss.** The enlarged part of a propeller post or strut, to take stern bearing. See Plate XXVII.

**Propeller shaft casing.** See Stern tube.

**Propeller shaft sleeve.** A bronze jacket shrunk on to propeller shaft for protection.

**Propeller shaft stays.** Strong flat iron bars fitted on each side in the "fun" of twin screw steamer, as supports for the outer bearings of the propeller shaft.

**Protection plates.** Narrow strips of plate, placed so as to protect edges of bow plating when hoisting anchor clear up.

**Puddening, pidding.** Old ropes, canvas, etc., used as pads on rigging to prevent chafing.

**Pulley.** A grooved wheel, fixed or suspended, over which a chain or rope passes.

**Pump.** An engine used for filling and draining the tanks, etc.

**Pump barrel, pump cylinder.** The upper cylindrical portion of a pump; space where pump bucket travels.

**Pump casing, pump well.** Any enclosure of wood or iron round the pumps, extending from the floors usually to the upper deck.

**Pump cover.** A lid by which the top of a pump is closed.

**Pump crosshead links.** Links connecting pump lever to pump crosshead. (Links connecting lever to engine are known as

engine crosshead pump links.) See Plate XXXV.

**Pump gear.** The gearing of a pump.

**Pump levers.** Flat iron bars, one end connected by links to the piston rod crosshead and the other end to the pump links, thus transmitting the motion of the piston rods to the pump rods. See Plate XXXV.

**Pump lever gudgeon, center gudgeon.** See Rocking shaft.

**Pump partners.** Angle bars, plates, pieces of timber fitted round the pumps for support.

**Pump rod.** The rod connected to the bucket or plunger of any pump.

**Punched rivet hole.** A rivet hole made by a punching machine.

**Punt.** A flat-bottomed, wall-sided boat, square at the ends, used as a platform for men when caulking, cleaning, or painting a vessel's outside when in harbor.

**Purser.** A person having charge of the mails; secretary; superintendent of the steward's department; accountant of provisions received and consumed.

**Quadrant.** A nautical instrument, on the arc of which is a finely graduated scale showing degrees and minutes, with adjustable reflectors, etc.; used to find the altitude of heavenly bodies, angular distances, etc. On a marine engine, quadrant bars are part of the reversing gear. On a steering gear, the rudder quadrant is a section of a wheel or sheave fastened to the rudder head.

**Quadrant thimble.** A distance piece between quadrant bars.

**Quadruple riveting.** The riveting together of parts by four rows of rivets.

**Quarter.** Those portions of the sides of a vessel about half-way between beam and stern, and in their position aft of the beam may be said to correspond with the bows, which lie forward of the beam.

**Quarter (of a ship).** The after end of a vessel; also, the sides of the after portion of one.

**Quarter deck.** The after portion of an upper deck.

**Quarter hatch.** See After hatch.

**Quarter iron.** An iron hoop, fitted on a yard about midway between its center and the yard end, forming the inner support of a studding-sail boom on a yard, and through which such boom is rigged out and in.

**Quarter man.** An officer having charge of a subdivision of workmen in a navy yard.

**Quartermaster.** An able seaman, almost exclusively emplyed for steering a vessel; on large steamers four to six men, so rated, relieve each other every hour or two hours. A petty officer in the navy.

**Quarter pillar.** A deck or hold pillar fitted about midway be-

tween the middle line and the side of a vessel; some hatchways are supported by quarter pillars fitted under their carlings.

**Quarter stanchion.** Another name for quarter pillar.

**Quarters.** The stations at which men should place themselves when called to their duties, as at fire drill or boat drill. Also used in reference to living accommodations; as, officers' quarters, men's quarters, etc.

**Quay.** An artificial landing place.

**Quicken.** To shorten the radius of a curve; as, to quicken a sheer is to make it more pronounced.

**Rabbet.** A longitudinal rectangular groove in wood or metal for the reception of pieces, the ends or sides of which are of similar section, so as to fit into the groove.

**Race.** A violent current arising from the meeting of two counter currents, as "Portland Race" in the English Channel.

**Racing.** A term given to the suddenly accelerated motion of a steamer's engine caused by the propeller blades or the paddle wheels being partly or wholly lifted out of the water by heavy seas.

**Rack.** A shelf, framework, etc., in which objects are secured to prevent them from moving about.

**Racking.** A piece of line by which two ropes, etc., are temporarily kept together before a seizing is laid on.

**Raft.** A collection of timber boards, etc., fastened together compactly by means of ropes, chains, etc., capable of being floated on a river, sea, or lake from one place to another.

**Raft ports.** The bow and stern ports, made to facilitate the loading and discharging of timber.

**Rail.** A guard made of flat pieces of wood, or iron bars or rods, joined, and connected to the upper edge of the bulwark plating, or fitted upon the summits of stanchions surrounding an upper deck, bridge, poop, or forecastle deck, etc.

**Rail stanchions.** The iron stanchions, about 3 feet high, placed about the same distance apart, fitted with several tiers of guard ropes, to enclose the sides and ends of a bridge, forecastle, or poop, and sometimes an upper deck.

**Raised quarter deck.** A structure interrupting the after portion of an upper deck, raised several feet above it, extending from side to side of a vessel.

**Raising iron.** A tool used by caulkers for clearing a vessel's seams.

**Rake.** The inclination of a vessel's mast, funnel, stem, etc., from its upright angle with the keel. The rake may be either

forward or aft. The elevation of the outer end of a bowsprit above the level of its inner end.

**Rally.** A rally is when gangs of men drive wedges between the cradle and sliding ways, all working steadily for 4 or 5 minutes.

**Ram.** A massive projection under water at the bow of a ship of war. The ship herself is also called a ram.

**Ratchet wheel.** A wheel having angular teeth fitted to winches, etc., for pawls to drop into, thus preventing the backward motion of the barrel to the end of which it is attached.

**Rate.** A merchant ship is rated, according to its relative safety as an insurance risk, as A1, A2, etc. Warships are rated, according to size, armor, guns, etc., as 1st rate, 2nd rate, 3rd rate, etc. To rate a ship's chronometer is to determine its error in 24 hours from true time. This rate of error must be taken into account in working out a position at sea.

**Ratline.** The three-stranded cord of which the ladder-like steps in lower rigging, topmast rigging, etc., are formed.

**Rave hook.** A caulker's tool, in form of a hook, used to pull old oakum out of the seams of planks.

**Reaming.** Using a reamer to make rivet holes fair and smooth on the inside. The equivalent English words are rimering and rimer. See Plate LIV.

**Recess bulkhead.** A bulkhead of any recessed portion of a hold or compartment.

**Recess of tunnel.** The elevated and extended portion of a tunnel. (At the after end such an enlargement of tunnel is called "stuffing box recess," while at the forward end it is known as "thrust recess.")

**Reciprocating pump.** Any pump having a "to and fro" or "up and down" action.

**Reduction gears.** The gears that reduce turbine speed to propeller speed. They constitute an important part of a turbine installation and may be located forward or aft of the turbines. Note particularly Plates XLIV and LVIII. The reduction is generally made in two stages. See Plate XLV.

**Reef.** To contract or reduce the extent of a sail by rolling or folding a certain portion of it and making it fast to the yard.

**Reef knot.** A square knot.

**Reef tackles.** Tackles of which one block is hung under the yardarm and the other connected to a cringle, fitted in the leach rope of a square sail, to haul the earring cringles as near as possible to the ends of the yards, greatly facilitating the reefing of the sail. The tackles take their name from the sails with which they are connected.

**Reeming.** The widening of the seams of new planking with a "reeming iron" so that oakum can be introduced by means of a caulking iron and mallet.

**Reeming iron.** A caulker's tool used to widen narrow seams so that oakum may be inserted.

**Reeving.** The passing of a rope through the sheave hole of a block; an earring through the cringle of a sail; a painter through the eye of a ring bolt fixed on the inside of a boat's stem, etc.

**Relief frames.** A contrivance to reduce friction on a slide valve face.

**Relief valve.** A valve in connection with a circulating pump, feed pump, etc., serving to relieve such pump from any overpressure of water.

**Relieving tackle.** A tackle that may be attached to tiller or a rudder to assist the steering in bad weather, or in case of accident; also, a tackle from a wharf to a masthead to ease and help to right a listed vessel.

**Render.** To reeve, to let pass, as a rope through a block, or where turns have been taken with a rope on a winch head on bitts.

**Reserve buoyance** (of a vessel). The lifting power. It may be measured by the volume of watertight hull above the load water line.

**Return connecting rod engine.** An engine so designed that the connecting rod works on the farther side of the crankshaft from the cylinder. It has two piston rods, one passing above, the other below the shaft, on opposite sides of the crank. Both rods are secured to a crosshead to the middle of which the "return connecting rod" is coupled, the object being to gain length of stroke in a limited space.

**Return flue boiler.** A boiler in which the smoke and heat from the furnace pass first into the combustion chamber, and from thence return through the tubes into the uptake and funnel.

**Reverse frame.** An angle fitted on the top edge of the floor plates, or inner edge of the frames. See Plate LXI.

**Reversing.** Change of motion, direction or position.

**Reversing link, slide valve link.** The bar or piece of machinery in connection with the upper end of the eccentric rods and the lower end of the valve rod.

**Reversing shaft.** A screw-threaded bar forming part of reversing gear to one end of which the reversing wheel is attached.

**Reversing wheel.** A hand wheel in front of an engine, within reach from the starting platform, for changing the motion of the valve gear when reversing the engine.

**Revolution counter** (tabulator). An indicator which records the

revolution of the engine. See Plate XLI.

**Ribands.** The molding round a vessel's side, or the painted decoration.

**Ribbands.** Planks, strips of wood or iron bolted outside the ribs to give stability to them during the building of the vessel. They may be marked with fore and aft location of frames.

**Ribs.** The timbers which form the skeleton of a boat.

**Rider.** A sort of interior rib fixed occasionally in a ship's hold when she has been enfeebled by service, though she may sometimes be built with them for extra strength.

**Rider keelson.** The upper one in case a keelson is constructed of two heights.

**Rider plate.** A plate fitted horizontally on top of a vertical-plate keelson, to which it is connected by angle bars; also, often fitted on top of hold bars, etc. See Plate VI.

**Riding.** The floor timbers which, gradually rising from the plane of the midships floor of a ship, give the shape to the parts of the bow and stern.

**Rig.** The rig of a vessel is the manner in which her masts and sails are fitted to her hull; there can be but two rigs, viz., square, and fore and aft.

**Rig.** Necessary support and brace for a drill.

**Rigger.** One whose occupation is to rig or unrig vessels, take up or down the yards, etc.

**Rigging.** The totality of a vessel's masts, spars, etc., with their standing and running ropes.

**Rigging screw.** An iron instrument used to squeeze together parts of standing rigging so that a seizing may be put on.

**Rim of a top.** The curved edge or border of a platform placed on the trestletrees of a lower mast.

**Riming.** The fairing of rivet holes in plating, angle bars, etc., when required, by means of a steel tool, a "rimer," before rivets are put in. (Generally spelled reaming and reamer.)

**Rise of floor.** The elevation of the arms of a floor above its seating. (In modern cargo ships it may be 6 or 8 inches.)

**Rivet.** A metal pin by which the plating and other parts of iron and steel vessels are joined. Rivets are known by their heads, such as flush, pan, snap, plug, tap, countersunk, mushroom, and bullhead.

**Rivet holes.** The punched or drilled holes in plating, frames, etc., into which the rivets are driven for connection.

**Rivet set.** A tool used in caulking around a rivet.

**Riveting.** To fasten with rivets.

**Riveters.** The men who do riveting. See Plate LV.

**Rocking shaft.** Any shaft used to impart a rocking motion to

other parts, i.e., the shaft forming the fulcrum of the pump levers.

**Rocking shaft brasses.** The brasses in which a rocking shaft works.

**Roller chocks.** Chocks with a short vertical roller fixed to ease a line passing through. See Plate XV.

**Rolling.** The tipping or tilting over of a vessel, alternately from one side to the other, in a heavy sea.

**Rolling chocks.** Another name for bilge keel.

**Rope.** A combination of fibrous material obtained from hemp or manila and spun into threads and twisted into strands. Several strands wound together form a rope. Iron and steel wire is also used in making rope.

**Rope yarn.** One of the threads forming the strand of a rope.

**Rose box.** A strainer fitted in a bilge or well to keep suction pipes clear. Called, also, strum box.

**Rose lashing.** A lashing that passes alternately over and under parts of the object lashed, the end being secured by passing circularly around the point of crossing.

**Roses.** Perforated pieces of metal fitted over the outside of sea-inlets, i.e., over apertures in the outside plating of a vessel, to let in sea water and prevent the entrance of any stray substance.

**Rotary shears** (for cutting steel plates.) Shears on which the cutting is done by revolving steel discs. See Plate LI.

**Round stern.** The modern shape of the stern—formerly square, but now elliptical or round.

**Rounded gunwale.** The curved portion of the frames and rounded plates forming the transition from the vertical side of a poop, bridge, etc., to the horizontal deck of such structure.

**Rounded gunwale plating.** The rounded or curved plates, usually fitted between the vertical side plating of a vessel and a bridge, forecastle, poop, or awning deck stringer, if the deck of such bridge, poop, etc., is of less breadth than the deck below either of them.

**Row of rivets.** A continuous line of rivets placed horizontally or vertically.

**Rowel.** A single block or pulley; "the iron or wood sheave or wheel for a whip tackle."

**Rowlock.** A lock or holding portion for a rowing machine, the fulcrum from which an oar obtains its leverage.

**Rowser chock.** A chock closed across the top.

**Royal mast.** A pole forming the third prolongation above a lower mast. It usually forms one spar with the topgallant mast.

**Royal sail.** A light upper sail, the one next above a topgallant sail.

**Rubbing piece (of wale).** A beading of wood or rope running round the outside of a boat just beneath the gunwale to protect it against injury in touching quays, piers, or other boats.

**Rubbing strip.** A thick narrow plate sometimes riveted outside a flat plate keel; a thick narrow plate or half-round molding placed along the side where it will protect the side plating when docking ship.

**Rudder.** A device hinged to the hull, outside, nearly always at the stern. It is the means by which a vessel is steered. See Plate XV.

**Rudder brace.** Sternpost brace, or gudgeon; a lug or projection on after part of sternpost to receive rudder pintle.

**Rudder arms or stays.** Arms projecting from the stock on alternate sides of center lines spaced opposite each of the gudgeons, which are from four to five feet apart; arms to which rudder plate is riveted. See Plate XV.

**Rudder bushings.** Metal thimbles, fitted round rudder pintles, or in rudder braces, as a lining, after the braces and pintles are somewhat worn by the constant turning of the rudder.

**Rudder clamp** (temporary). A clamp made of timbers bolted so as to keep rudder straight while launching. See Plate XV.

**Rudder flange.** A flange for joining rudder head to main piece. See Plate XV.

**Rudder frame.** The rudder, exclusive of the plating, or the "bow of the rudder."

**Rudder head.** The upper end of the main piece, to which the tiller is fixed.

**Rudder head plate, rudder partner plate.** A plate fitted on the aftermost upper deck poop, or raised quarter deck beams, having an aperture immediately above the rudder trunk through which the rudder head passes, thus forming part of the helm port.

**Rudder heel.** The lower portion of the main piece of a rudder.

**Rudder-heel bearing.** A bearing for the rudder heel; i.e., the bottom bearing on a rudder post.

**Rudder lock.** A metal cleat, fitted in a pintle score under one of the upper pintles of the rudder, to prevent the rudder being accidentally unshipped.

**Rudder pendants.** Chains or strong wire ropes, attached by a shackle to the back of the rudder frame of iron or steel ships, and to the preventer tiller of wooden ships, leading over the stern, and intended for use as temporary steering gear, should any accident happen to the rudder tiller, rudder head, etc.

**Rudder pintle bolts.** Bolts by which the metal strap in connection with a rudder pintle is fastened to the rudder.

**Rudder pintles.** The metal pins forged on the fore-side of the main piece of a rudder turning in the rudder braces.

**Rudder plating.** The plates fitted on and riveted to a rudder frame.

**Rudder post.** See Sternpost.

**Rudder rivet.** Any rivet by which the rudder plating is secured to the rudder frame.

**Rudder snug or gudgeon.** A lug or projection on forward part of main piece to take rudder pintle.

**Rudder stays.** Pieces of metal fitted horizontally between the main piece and the bow of the rudder, to which they are welded.

**Rudder stock.** The main piece of a rudder. See Plate XV.

**Rudder stops.** Usually projections in the stern frame or on the rudder post to keep the rudder from turning too far.

**Rudder trunk.** A casing consisting of plates surrounding the upper portion of the main piece of the rudder or rudder head, extending abaft the sternpost from the lower part of the counter up to the deck; the interior of the rudder trunk forms part of the "helm port." One and sometimes two stuffing boxes are located in a rudder trunk to prevent the sea from entering the hull.

**Run.** The narrowing of a vessel's after bottom.

**Running rigging.** Ropes by which yards are braced, sails hoisted or hauled down, etc.; movable rigging.

**Rust putty.** A putty made by mixing the borings or filings of cast iron with sal-ammoniac. They will form a pasty mass, employed by engineers as luting, etc., in joining the flanges of iron pipes, etc.

**Saddle.** A hollowed block of wood on a bowsprit in which the heel of a jib-boom is lodged; also, a wooden collar round a mast, upon which the jaws of a boom rest.

**Safety collar.** A collar or ring fitted to prevent parts of an engine, etc., from starting loose or to prevent the blowing out of an expansion joint of a steam pipe.

**Safety keel.** A garboard composed of several strakes of thick plating.

**Safety ring, check ring, guard ring.** A ring fitted to protect or keep in place certain things.

**Safety valves.** Valves fitted to boilers, superheaters, etc., to prevent explosions, or other accidents, arising from excessive pressure, if unrelieved.

**Safety valve box, safety valve casing.** The casing protecting a safety valve.

**Safety valve drain pipe.** A pipe, fixed under the safety valve box on a boiler, leading water condensed from the escaping

steam into the bilges, or the tanks.

**Sag, sagging.** A dropping or depression; therefore, in a keel, the opposite of hogging.

**Sagged.** When from some cause a vessel's form is so altered that the ends of the keel are much above the level of its midship portion, it is said to be "sagged."

**Sail.** A device made of canvas and rope so it may be extended, by means of spars or rigging, for the purpose of catching the wind and driving the vessel.

**Sail needle.** A heavy three-cornered needle.

**Sail of a lugger.** A four-sided sail bent to a yard and slung to the mast in a fore-and-aft position.

**Salt stops.** Short pieces of wood placed between the frames above the bilges, just above the various air courses, to keep the salt in its place, in case a vessel is salted to preserve its timbers.

**Sampson post.** A heavy vertical post to support cargo booms.

**Saturated steam.** Steam having the same temperature as the water from which it is raised.

**Saturation.** The point of infusion at which no more of the substance (as salt) can be held in solution.

**Save-all, drip pan.** A cup or vessel suspended to catch dripping oil.

**Scale.** The incrustation of salt, lime, etc., in a boiler or other receptacle.

**Scaling hammer.** A hammer to beat off scale or oxidation from iron or steel plates, angle bars, etc.

**Scantling.** Dimensions, breadth, and thickness of either wooden, steel, or iron keels, stems, sternposts, beams, frames, etc.

**Scantling of frames.** The breadth of frame flanges in inches, etc., and the thickness at their half breadth.

**Scarph, scarf.** The connection of two pieces of timber by the overlapping of their shaped ends so that they make one beam of uniform size throughout. Smiths scarph ends of iron or steel for welding. To cut plates so that when assembled does away with liners. See Plate XXVII.

**Screen.** A bulkhead to keep out dust (not watertight) found between boiler and engine rooms.

**Screen bulkhead.** A screen formed of platings, fitted in a stokehold, to prevent the entrance of cold air striking the boilers suddenly.

**Screw.** A cylinder having a spiral thread winding round it at equal distances. The distance center to center of each spiral thread is called the "pitch" of a screw.

**Screw aperture.** The opening between the sternpost and propeller post of a screw steamer, in which the propeller revolves. See Plate XXVII.

**Screw boss.** The thicker central portion of a screw propeller,

to which movable blades are attached by studs and nuts.

**Screw jack.** A hoisting or lifting jack operated by a screw.

**Screw post, propeller post.** The inner sternpost of a screw steamer. See Plate XXVII.

**Screw propeller.** A propeller having blades or paddles set at an angle and twisted like a screw thread of steep pitch, which when driven by a shaft forces the vessel forward.

**Screw race.** See Screw aperture.

**Scrieve board.** A large surface of flooring in the mold loft in which the lines of the body plan are cut with a knife. Used for making molds of various parts.

**Sculling.** The propelling of the boat through the water from the rear with a single oar.

**Scum cocks, brine cocks, surface blow-off cocks.** Cocks fixed, one on the back plate or shell of a boiler, in connection with the brine pipe, the other to the shell plating of the vessel, serving for the extraction and discharging of salt, etc., from the water in the boiler.

**Scum valve, brine valve.** A valve sometimes fitted in lieu of a brine or scum cock.

**Scuppers.** Round or oval apertures, serving to lead off small quantities of water, to prevent it accumulating on a vessel's deck.

**Scupper holes.** Holes cut through the gunwale angle bar and the adjoining sheerstrake, or through any plate or shape, for scupper pipes to pass.

**Scupper pipes.** Pipes by which the water from a deck is conducted between the frames to the bilge. Scupper pipes from upper decks often lead directly outboard or to the waterway of a lower deck.

**Scuttle.** A small aperture in a deck, in the side plating or planking of a vessel, in a bridge or a poop bulkhead, etc., principally to admit light and air.

**Scuttle frame.** The metal frame enclosing a bull's-eye.

**Scuttle, to.** To sink a vessel by means of boring or cutting holes through her bottom.

**Sea cock, sea connection.** Any cock attached to the outside plating (usually above the engine room or stokehold platform) in communication with the sea.

**Sea room.** The distance from land, banks, or shoals, etc., that a vessel could sail or drive without danger of stranding.

**Sea valve.** Any valve attached to the outside plating, in communication with the sea.

**Seam.** The line where the edges of plates or planks meet when joining each other.

**Seam strap.** A narrow plate used to cover a butt seam.

**Section.** A drawing representing the internal parts of a vessel as if she had been cut straight

through, either longitudinally or athwartships.

**Sector or slide sweep.** A piece of metal, in form of a sector of a circle, sliding between two upright columns, forming part of the valve motion of an oscillating engine.

**Sediment.** The particles deposited from water in a ship's boiler, etc.

**Seize.** To secure, as to fasten two ropes or different parts of the same rope together with a binding of small rope or yarn.

**Seizing.** A piece of marline, houseline, etc., by which two ropes are bound together; the eye on one rope secured to another rope, etc.

**Self-lubricating bearing.** A bearing fitted with a self-acting lubricator, or one lubricated by sea water.

**Semi-box orlop beam.** A beam of box-like construction, as made by two channels and a plate or two bulb angles and a plate. They are located in the hold and are extra stiff in a fore-and-aft direction.

**Sennit.** A cord of from three to nine or more threads formed of rope yarns or spun yarns, plaited by hand in various modes, and then called "common sennit," "round sennit," "French sennit," "square sennit," etc.

**Sennit valve, alarm valve.** A very small relief valve on the boilertop, to give alarm in case the safety valve should prove defective and the steam gauges not indicate the pressure.

**Serve** (to serve rope). To bind rope round with canvas and line.

**Serving.** The material with which a rope is served; spun yarn, rope yarn, marline, etc.

**Serving board.** A small wooden tool used to serve small ropes for which a serving mallet would be too large.

**Serving cord.** Cord for wrapping about a rope or splice. The three chief kinds are: Marling, one strand; House line, three strands (light); Round line, three strands (heavy).

**Serving mallet.** A wooden tool employed for serving.

**Set.** A metal template around which a frame is bent (used on a bending slab).

**Set hammer.** A hammer used in giving a shape its final form.

**Set iron.** A bar of soft iron used on bending blocks in shaping frames.

**Set up.** To take up the shrouds so that they have an even and proper strain.

**Shackle.** A link with a movable bolt, by means of which two lengths of chain cable are joined or separated. Blocks have a special form of shackle, made by extending the strops beyond the end opposite the eye and passing a bolt through holes in the end of the strop.

**Shacklebolt.** A bolt that goes through a shackle.

**Shacklebolt pin.** An iron or wooden pin, driven through one eye of a shackle and through the headless end of the shacklebolt, to prevent the latter starting.

**Shade deck.** A deck of very light construction, erected above the main deck of a vessel as a protection from sun and rain.

**Shade-deck vessels.** Vessels having a continuous upper deck of light construction, with openings on sides.

**Shaft, spare.** An extra tail shaft. (Steamers generally carry one or more stowed in the shaft alley.)

**Shaft bearing, bearing of a shaft.** That part of a shaft in contact with the bed; also, the bed in which it revolves.

**Shaft coupling.** The means of connecting any two lengths of shafting.

**Shaft hole of a propeller post.** The aperture into which the stern tube is fitted, through which the propeller shaft passes and in which it revolves. See Plate XXVII.

**Shaft of an anchor.** The main shank or leg.

**Shaft stools.** The foundations to which the shaft bearings are bolted.

**Shaft tunnel, shaft alley.** The passage enclosing engine shaft; extends from engine-room after bulkhead to the stuffing-box bulkhead. See Plate XXXII.

**Shank of an anchor.** The body of the anchor extending through the anchor beam to the crown or arms.

**Shapes.** Steel bars of various cross-sections. See Plate LIX.

**Shears.** An erection of two or more spars, the lower ends spreading apart, the upper ends connected and fitted with tackles, etc., for lifting heavy weights. Used on a vessel's deck or quay for hauling where no crane is available for such purpose. A machine or tool for cutting. See Plate XLVIII.

**Shearing.** Cutting or trimming the edges of steel members.

**Sheathing.** A covering of sheets of yellow metal, copper, or zinc, or of boards; takes its name from the material used. The sheathing serves as a protection from the sea worm and prevents fouling.

**Sheave** (of a block). The disc of hard wood or metal in a block which revolves with the working of the rope or chain passing over it.

**Sheave, a dead sheave.** A half sheave inserted anywhere for ropes to pass over, while fixed in its position and not revolving.

**Sheave holes.** Oblong apertures in masts, spars, booms, etc., in which sheaves revolve, and through which ropes or chains travel.

**Sheepshank.** A certain kind of knot, usually put in a rope to shorten it.

**Sheer.** The curve of a vessel formed by the line of her upper deck at the sides. If the fore end of the deck is 4 feet, and the after end 2 feet above the midships level, she would have a mean sheer of 3 feet

**Sheer batten, sheer pole.** An iron bar fixed in a fore-and-aft direction to the lower portion of the shrouds of lower rigging, etc., to prevent such rigging turning.

**Sheer plan.** The drawing in which the sheer is shown; a longitudinal section through the keel showing the position of every point with respect to its position fore and aft, as well as its height above the keel.

**Sheer plate.** Any plate in a sheerstrake.

**Sheerstrake.** A strake immediately below the sheer line. It is often of thicker planking than the other strakes in wooden ships.

**Sheerstrake.** The uppermost strake of plating in the topside of a vessel; also, the uppermost strake covering the outside of forecastle, poop and raised quarter deck frames.

**Sheerstrake plate.** Any plate forming part of a sheerstrake.

**Sheet anchor.** The most powerful anchor carried by a ship, and popularly supposed to be used only as a last resource.

**Shell doubling.** An extra plate added to strengthen the shell.

**Shell landings.** The lap of the strakes or courses of the shell plating.

**Shell liners.** Pieces of plate between the frames and the outside strake of plating, tapered in the case of clinker plating, and where the outside strake is not joggled the liner is simply a piece of flat bar of the same width as the frame flange, and extends all the way between the edges of the inside strakes. See Plate LIX.

**Shell plating.** The plating on outside of hull of ship. See Plate XXIX.

**Shelter deck.** The upper deck in shelter-deck vessels. See Decks.

**Shelter-deck beams.** The beams on which a shelter deck is laid.

**Shifting beam.** A beam to support a hatch cover. The ends rest in sockets on the inside of the hatch coaming, therefore easily movable.

**Shift of butts.** The arranging of joints so they do not come opposite one another, "a good shift" meaning joints well placed to give strength.

**Shifting boards.** A light or portable bulkhead on the center line of the ship, fitted in place when a ship is carrying grain or any cargo that would otherwise shift with the rolling of the ship.

**Ship.** A full square-rigged vessel.

**Ship chandler.** A person or firm dealing in ship commodities or provisions necessary for a ship's use on a voyage.

**Ship fitter.** A mechanic who makes templates, marks, assembles, and fastens in place plates

and shapes for the hull of a ship. Should be able to do any fitting on ship.

**Shipwright.** A ship builder, or one who works about a ship. Does wood carpentry on a ship and keeps ship faired. Builds launching ways and launches ship.

**Shore.** A strong piece of timber used in any manner as a support for some object needing it. See Plates IV and VI.

**Shoring.** The act of supporting anything by shoring it up.

**Short-link chain.** A term used to describe a chain cable having links without studs.

**Short splice.** The union of the ends of ropes made by tucking the strands of each end abreast of one another. (This gives a thick bunchy splice that is chiefly used for straps, slings, etc. It would "jam" in a block.)

**Shroud.** A stay run from side to masthead to support mast.

**Side** (of a ship). Term applied to the exterior of the outside plating or planking from the level of the upper deck down to the bilge.

**Side bar keel.** A keel formed by riveting a bar (or thick plate) to both sides of a vertical keel. The garboard strakes flange down and rivet to it.

**Side bitt** (of a windlass). Either one of the two bitts to which a windless is framed, to bear the strain.

**Side bunker, side coal bunker.** A bunker situated in the side of a steamer, usually abreast of the boilers.

**Side girders.** Girders fitted between the center girders and the margin plates of double bottoms.

**Side girder angle bar.** An angle bar used in connection with side girders.

**Side girder plate.** Any plate used in the construction of a side girder.

**Side intercostal keelson.** A keelson located between center keelson and the bilge and built of vertical plates between the floors in connection with a side keelson upon the floors or with the tank top.

**Side intercostal stringer.** An intercostal stringer fitted above a bilge stringer.

**Side intercostal stringer angle bar.** An angle bar connecting a side intercostal stringer plate to the shell plating. (Note.—The angle on the inner edge is called a face angle.)

**Side keelson.** A girder placed about midway between the middle line and the bilge keelson, similar in construction to the bilge keelson.

**Side light.** A thick piece of round glass framed and inserted in the side of a vessel, side of a deck house, etc.

**Side lights.** Lights used to show that a vessel is under way: a red light on the port side and a

green light on the starboard side.

**Side-light screens.** Two open casings of wood or iron, one on each side of the bulwarks or superstructure of a vessel, for the reception of the side lights, so constructed and placed that the lights are not seen across the bows.

**Side pieces, side bars.** Bars to fit a corrugated furnace.

**Side plating.** The plating covering the sides or main body of a vessel, or the sides of a bridge, a poop, etc.

**Side scuttle.** An opening or hatchway in the side of the ship to discharge garbage, etc.

**Side stringer.** A stringer, composed of angle bars or any other material, fitted in one-decked vessels about midway between the deck and the bilge; in vessels having several decks, between the lower deck or hold beams and the bilge stringer.

**Siding of a beam, floor, or frame.** Its dimension measured in a fore-and-aft direction.

**Siding of a keel, keelson, stem, or sternpost.** Its dimension athwartships.

**Signal flags.** A set of flags that represent the alphabet, generally used with a code. Any flag may be used to signal with; as, for instance, an ensign hoisted upside down means, "We are in distress."

**Sill.** The stone foundation immediately under the gates, at the entrance of a dry or wet dock. Also, the bottom of a port frame, the coaming forming the foundation of a deck house, poop, etc., or that portion of the coaming under the foot of a door.

**Single block.** A block containing only one sheave.

**Single crank.** A shaft with but one crank web.

**Single-ended boiler.** A boiler fired from one end only.

**Single-expansion engine.** An engine in which the steam expands in one cylinder only.

**Single-plate keelson.** A keelson having but a single plate in cross section.

**Single-plate rudders.** Rudders in which a single plate is fitted between and riveted to the supporting arms. The plate may engage in a groove cut down the back of rudder stock.

**Single riveting.** The connection of edges or butts of plates, etc., by a single row of rivets.

**Sister block.** A block having two sheave holes, one above the other.

**Sister hook.** A hook consisting of two parts on a common eye. When closed they form a seemingly solid eye.

**Sister keelson.** Long pieces of timber, connected endwise by scarphs, placed on each side of a main keelson, and extending as far forward and aft as practicable, for the purpose of giv-

ing additional strength at the middle line of a vessel.

**Sister keelson bolts.** Bolts used to fasten a sister keelson horizontally to the middle line keelson and vertically to the floors. They are used a trifle less in size than the middle line bolts.

**Skeg of a keel, keel skeg.** A skeg is the heel, or extreme after end of the keel, which in some vessels projects slightly abaft the sternpost. (Used to support heel of rudder.)

**Skeleton of a vessel.** The hull without the outside and inside plating or planking.

**Skid beams, boat skids.** Beams supported by stanchions above the bulwarks, often extending from side to side of a vessel, for boats, spars, etc., to be stowed on.

**Skids.** A framework hung over a vessel's side during loading and discharging, to prevent casks or similar cargo chafing the side of the vessel.

**Skiff.** A long lightly built boat, sometimes employed in match rowing.

**Skin.** The outside or inside covering of the frame of a vessel by plating or planking.

**Skylight.** A framing of wood or metal, fitted over an aperture in a deck, with window-glass inserted for the admission of light into a cabin, engine room, crew space, etc.

**Skylight coaming.** The framing of woodwork or metal forming the base of a skylight.

**Skylight cover.** A protection of canvas, cut to required shape and sewn together.

**Skylight grating.** Guards of brass or other metal protecting the windows in a skylight.

**Slack.** The looseness of ropes, rigging, etc., not firmly stretched.

**Slab, bending.** The cast-iron floor in front of plate and angle furnace where the frames are heated and bent. See Plate XXXI.

**Slack away, to.** To pay out a rope; to render or let a rope run out carefully.

**Sleeve.** A brass liner encircling any shaft; often found on a propeller shaft.

**Sleepers.** Heavy timbers beneath the cribbing for keel blocks. See Plate I.

**Slide valve.** A valve that slides in its seat instead of rising or rolling; a sliding piece in the steam chest, regulated to move back and forth over the ports at the end of the cylinder and connect them alternately with the boiler and the exhaust, thus imparting a reciprocating motion to the piston.

**Slide valve balance cylinder.** See Balance cylinder.

**Slide valve casing, slide valve box, slide valve chest.** The cast metal receptacle in which a slide valve works. In small engines it is generally cast in one

piece with the cylinder; in large engines it is usually a separate casing, and fastened to the cylinder by screw bolts.

**Slide valve casing door, steam-chest cover.** The cover by which a slide valve casing is closed.

**Slide valve face.** The smooth surface of a slide valve, that glides over the ports of a cylinder.

**Slide valve gear, valve gear.** A term given collectively to all the parts operating a slide valve.

**Slide valve link, valve link, reversing link.** The bar or piece of machinery in connection with the upper end of the eccentric rods and the lower end of the valve rod.

**Slide valve packing ring.** A ring inserted at the back of a slide valve to keep it up to the cylinder face.

**Slide valve rod, valve rod, slide valve spindle.** The rod in connection with a slide or expansion valve and the reversing link.

**Slide valve rod eye.** An eye in bottom end of valve rod. Connects rod to link.

**Slide valve rod eye bolts.** Bolts for removing slide valve.

**Slide valve rod nuts.** Nuts for adjusting travel of rod.

**Slide valve spring.** Spring holding valve in position.

**Sliding ways.** That part of launching ways "which travels with ship when launched." See Plate XVI.

**Sling.** A length of chain or rope, with a tackle or the chain of a crane, etc., attached, for lifting or lowering goods.

**Slip.** The loss at each revolution made by a screw propeller or paddle wheel due to their not advancing the distance they would if no resistance were offered to their forward motion; the inclined plane upon which a vessel is built or repaired.

**Sloop.** A vessel with one mast like a cutter, but having a jib sail which a cutter has not.

**Slop shute.** A shute for discharging garbage clear of ship's side.

**Slot link.** A reversing or slide valve link in form of a slotted bar.

**Sludge hole, mudhole.** An aperture in front of the boiler, just above the bottom, through which deposited mud is removed.

**Sluice.** An aperture in the lower part of a vessel's bulkhead, fitted with a sliding door worked from above, by the opening or closing of which water may be admitted or the flow stopped.

**Sluice cock, sluice valve.** A cock or valve fitted to a watertight bulkhead for shutting off or allowing the flow of bilge water towards the pumps.

**Sluice valve rod, sluice valve spindle.** A rod by which a sluice in a watertight bulkhead, etc., is opened and shut.

**Slush.** Floating grease left after boiling meat on board ship, and

used for lubrication or to grease standing rigging.

**Smoke box.** The casing on front of boiler joining it to uptake. See Plate XXXVIII.

**Smoke-box door.** A door by which smoke box is closed. Gives access to tubes for cleaning. See Plate XXXVIII.

**Smoke sail.** A canvas screen before the funnel of a galley, cabin, crew space, etc., to prevent the smoke being driven about, causing dirt and annoyance.

**Snaffle or shaffle.** A collar with open ends, one of the fittings of a boom to its mast.

**Snap rivet.** A rivet driven with a snap die. (Has a round or button head.)

**Snatch block.** A block hinged on one side of the shell, which opens to allow the bight of a rope to be laid over a sheave, to avoid the passing of the end through the block.

**Snifting valve.** A small-sized valve fitted to a condenser to permit the escape of air and water ejected by the steam when "blowing through," closing automatically to prevent any communication between the atmosphere and the interior of the condenser.

**Snubbing.** Bringing a vessel up suddenly with an anchor and short cable; to check a line or cable from running out by holding a turn about bitts, cleat or pin.

**Snug.** A hinge in a rudder.

**Snug fit.** A close, neat fit of parts put together.

**Sole.** A cabin deck is sometimes called by this name.

**Sole piece** (of a stern frame). The bottom piece joining rudder post and sternpost when they are built of separate pieces scarphed together; the piece of keel between the sternpost and the propeller post.

**Sole plate.** A foundation plate to which the base of an engine or a pump, etc., is bolted.

**Solid hatches.** Hatchway covers composed of close jointed planks or boards, sheet iron, or steel, thus differing from hatch gratings.

**Sounding lead.** The lead weight used on a sounding line.

**Sounding line.** A weighted line for determining depth of water.

**Sounding pipes.** Pipes about two inches in diameter, extending from the upper deck into the well or double bottom, into which a sounding rod is dropped to ascertain the depth of water.

**Sounding rod.** A light iron rod about two to four feet in length used in the sounding pipes.

**Spacing of beams.** The distance apart of beams in the same tier, in small vessels about 40 inches, in large ships 48 to 52 inches apart. In the case that iron and steel decks are fitted without a wood flat in them, there is usually a beam to every frame.

**Spacing of rivets.** The distance from the center of one rivet hole to the center of the next, depending on the diameter of the rivets and the purpose for which they are employed.

**Span.** A rope bent so as to form two legs.

**Spanish windlass.** A rig made with a piece of line and a handspike or a belaying pin so that by twisting the middle part the ends will be drawn nearer together.

**Spanner.** A wrench; a tool made to grip and turn special fittings about a pump or an engine, as a hose spanner is used to screw up hose couplings.

**Spar.** A general term for any shaped piece of timber employed as a mast, bowsprit, yard, boom, gaff, etc., or intended for such use.

**Spar deck.** An upper deck, stronger than an awning deck but not so heavy as a promenade deck.

**Spar-decked vessel.** A vessel constructed with the deck above the main deck heavier than in an awning-decked vessel, but not so heavy as in a full three-decked vessel.

**Spare bunker, spare coal bunker.** A bunker in which coal is kept in reserve.

**Spare gear.** Shafts, valves, rods, brasses, boiler tubes, bolts, nuts, etc., kept in reserve.

**Speaking tube.** A tube, leading from one part of the vessel to another, through which orders or messages are conveyed; as from the deck to the engine room, etc. See Plate XXXIII.

**Spectacle frames.** Frames of special shape to allow passage way for propeller shaft in twin-screw vessels.

**Speed-control valve.** A valve to give convenient control of engine speed. See Plate XLIII.

**Spirketting.** The first strake of inside planking immediately above a waterway, somewhat thicker than the common 'twixt-deck ceiling. Those inside of an upper-deck waterway, inside of a poop or a forecastle, are termed respectively (in wooden ships) spirketting of forecastle, spirketting of poop.

**Spirketting plate.** A vertical plate stringer fitted immediately above the lower deck or the hold beams, against the frames, to which it is riveted. Rarely met with except in some composite vessel. A plate in line with shell plating and extendng above forecastle deck. Sometimes called waist plate.

**Splice.** A method of joining ropes by interweaving the strands.

**Split pillar.** A double pillar, fitted for the reception of shifting boards.

**Sponson or sponsing.** Reinforcement between the paddle box and the vessel's side, in a paddle-wheel steamer.

**Sponson beam, spring beam.** A longitudinal girder, placed on

the extremity of the paddle beams, serving with the latter to support the paddle box.

**Sponson deck.** Term given to the platform, usually consisting of close-jointed planks or strong battens, laid and fastened on joists fitted between the super-beams and the side of a paddle steamer.

**Spot face.** To smooth off the surface around the top or bottom of a hole.

**Spread.** The distance at right angles to the center line.

**Spring.** The amount of curvature in a sheer line; i.e., the rise given a deck as it runs forward or aft.

**Spring line.** A line run from a vessel to a dock so as to hold vessel from going ahead or astern. In the first case it leaves vessel well forward and runs to a point on the dock nearly abreast the stern. In the second case, the reverse is true. Lines so run are often used to help swing a vessel clear of a dock.

**Spritsail.** A boat sail extended by a sprit. Formerly carried under the bowsprit of sea-going vessels.

**Sprung.** A mast or spar is said to be "sprung" when cracked; or a vessel when hitherto tight, but suddenly discovered to be making water.

**Spun yarn.** A thin yarn made of two or three yarns, twisted together by a spun-yarn reel.

**Spur beams.** Pieces of timber or iron or steel girders, extending from the ends of the sponson beam in a diagonal direction to the main body of a paddle steamer as supports of the paddle beams.

**Spur of bulwark stay.** The diagonal cross-piece on a bulwark stay.

**Spur shore.** A slanting brace on either side of ship or ways.

**Square body frames.** Those with a great curvature forming the middle part of the skeleton of a vessel.

**Square stern.** A stern which meets the water at a right angle, cut off square on deck line.

**Stability.** The tendency in a boat to keep the upright, or to return to it when careened over.

**Stage.** A platform of boards or planks, hung in ropes or otherwise supported, for a person to stand upon when cleaning, scraping, or painting the outside or inside of a vessel.

**Stanchion.** A fixed upright support. See Plate XV.

**Standard.** A knee or bracket placed above the object to which its horizontal arm is bound, i.e., in an inverted position.

**Standing rigging.** The ropes by which the masts, bowsprit, jib-boom, etc., are supported.

**Staples.** Angles around shapes and connected to plate, fitted watertight. See Plate XL.

**Starboard side.** The right-hand side, looking from aft forward.

**Starting cock.** A cock fitted on the low-pressure cylinder (in

absence of a starting valve) for supplying steam from the starting steam pipe to said cylinder to assist in starting the engine.

**Starting gear.** The lever, screw, or wheel, rods, etc., by means of which an engine is started ahead or astern.

**Starting lever.** A lever acting upon the gear by means of which an engine is started.

**Starting valve, auxiliary valve.** A valve fitted on the cylinders for the purpose of admitting steam, either for effecting or expediting the starting of the engine.

**Starting valve gear.** The levers, rods, etc., by which a starting valve is opened or shut.

**Stateroom.** A place for lodging in a ship's cabin; passenger's room.

**Staunch.** A word used in charter-parties, and meaning that a vessel is firm, sound, and strong.

**Stays.** Bars used for binding or supporting or holding parts together.

**Stays.** Supports of hemp or wire by which masts and spars are supported.

**Steam-chest cover bolts, valve-casing door bolts.** The bolts by which the door or cover of a steam chest is secured to the casing or chest.

**Steam cock.** Any cock by means of which steam is supplied or shut off; for instance, the steam cock on a water gauge column.

**Steam jacket.** An outer casting surrounding a cylinder. The free space between the cylinder and the jacket is kept filled with steam, to maintain an equal temperature of the cylinder.

**Steam port, admission port.** The channel through which the steam enters a cylinder from the valve casing.

**Steam reducing valve.** A self-acting valve placed in a steam pipe to supply steam for use, where it is required, at a lower pressure than it issues from the boiler.

**Steam seals around spindle.** A device in a turbine to hold pressure.

**Steam steering gear.** The steam engine and its connections used for controlling a vessel's rudder. In large vessels steam power is supplied to assist the helmsman.

**Steam reversing gear.** Term applied where steam is used to handle reversing mechanism on reciprocating marine engine.

**Steam waste pipe, steam escape pipe.** A pipe extending from the deck nearly to the height of the funnel, to which it is attached and into which the steam from the safety-valve pipe passes and escapes into the open air.

**Steamway.** The passage in a steam pipe, or the steam ports in a cylinder, through which the steam is conducted.

**Steam windlass.** A patent windlass worked by steam.

**Steel boiler.** A boiler made of steel plates riveted together.

**Steel mast.** A mast built of iron or steel plates, bent and riveted together to form a hollow cylindrical column, usually strengthened inside by vertically fitted angle bars. See Plate XLIX.

**Steeler plate.** A plate taking two strakes, used near either end.

**Steep tub.** A tub in which salted provisions are steeped in water before cooking.

**Steerage.** That part of a vessel having the poorest accommodations and occupied by the steerage passengers, or those paying the lowest fare.

**Steerage way.** Progress through the water sufficient for a vessel to answer the helm; i.e., so that the turning of the rudder will make the ship move round in the desired direction.

**Steering chain.** A chain connecting quadrant to steering wheel.

**Steering gear.** All of the parts, fittings, etc., communicating with the rudder head, by means of which a vessel's rudder is turned and controlled.

**Steering quadrant.** A heavy piece of iron or steel in quadrant shape, fitted on the rudder head of a vessel.

**Stem.** The heavy piece of iron or steel usually extending in one length from the keel to above the upper or forecastle deck, and forming the extreme fore end of a vessel. See Plate XXVIII.

**Stem cap.** A small plate on top of a stempost.

**Stem piece.** A piece of timber, or chock, fitted as a filling piece (if required) between the stem and a knighthead in wood ship.

**Stem plate.** A plate fitted flat against the inside of the lower portion of the stem, in composite vessels, for additional strength.

**Stem rivet.** A rivet by which the forehood ends of the outside plating are fastened to the stem.

**Stemson.** A curved timber behind the apron of a vessel, and supporting its scarphs.

**Stemson bolt.** A bolt connecting a stemson to a sternpost; or connecting a stemson to an apron.

**Step of a mast.** A piece or combination of pieces of timber, iron, or steel forming a bed under the foot of a mast.

**Step.** To set in place as applied to a mast.

**Stern.** The after end of a ship, that portion above the counter and abaft the sternpost.

**Stern bushing.** A short tube of mixed metal, inserted in the after end of a cast-iron stern tube, usually lined with strips of lignum-vitæ, and serving as a bearing for the propeller shaft of a screw steamer.

**Stern casting or frame.** A heavy steel casting or forging at stern of vessel supporting the rudder and to which the shell plate

strakes are fastened. See Plate XXVII.

**Stern molding.** Battens and sculpture used for ornamenting the stern plating or planking.

**Stern pipe.** A round or oval aperture in the upper part of a vessel's stern above an upper deck, poop deck or raised quarter deck, for passing mooring chains, warps, etc., through for mooring the after end of a vessel.

**Stern plating.** The plating covering the outside of stern.

**Sternpost.** The principal member of a vessel's stern frame. See Plate XXVII.

**Sternpost plate.** A plate fitted against the lower portion of the stern, or inner post, in a composite ship.

**Sternpost rivet, propeller post rivet.** A rivet by which the after hood end of the outside plating is riveted to a sternpost or propeller post.

**Stern tube.** The tube through which propeller shaft turns. It makes a watertight connection between the stuffing box and the propeller post.

**Stern tube stuffing box.** A stuffing box on the inner end of the stern tube, at the after-peak bulkhead.

**Stern tube flange.** A flange on forward end of stern tube bolted to bulkhead.

**Stern tube nut.** A nut in form of a ring, fitted on the after side of a propeller post, keeping the stern tube in position.

**Stern wheel.** The wheel by which a stern-wheel steamer is propelled.

**Stern-wheel steamer.** A steamer propelled by a paddle wheel at the stern.

**Stiff, stiffness.** The quality of stability possessed by a vessel; in other words, the capability under sail to keep the upright, or return to it when keeled over.

**Stiffeners.** Shapes fastened to plates for reinforcements. See Plate XXV.

**Stiffening.** Any heavy substance taken on board a vessel for the purpose of making her stiff.

**Stirrups.** In a square rig, short ropes hanging from the yards and supporting the foot ropes.

**Stockless anchor.** An anchor without a stock. Most modern anchors are stockless.

**Stocks.** The inclined framework of timber in a shipbuilding yard upon which a vessel rests while under construction and from which she is launched.

**Stock of a rudder.** The upper part upon the head of which the tiller is set.

**Stock of a bowsprit.** That part at the foot which is held by the bitts.

**Stokehold.** The place in the boiler room of a steamer from whence the boilers are fired, etc.

**Stokehold bulkhead.** The bulk-

head separating the boiler space from a thwartships bunker.

**Stokehold flooring.** The flooring in a stokehold, usually iron plates, raised up from the tank top. See Plate XXXVIII.

**Stokehold ventilator.** A ventilator fitted over the stokehold of a steamer.

**Stomach piece.** Another name for apron (in wood ships).

**Stool, shaft.** A foundation for holding shaft bearing.

**Stools of steam winch pipes.** Small blocks, usually of cast iron, fastened at intervals upon a steamer's deck and in which steam winch pipes are bedded.

**Stop.** Any contrivance to arrest the action of moving parts.

**Stopper, stoppering.** To check or hold fast any rope.

**Stopcock.** Any cock used to control the passage of steam or water.

**Stop valves.** Valves fitted to cut off the supply of steam, or to close steam communication between boilers and cylinders, or between the latter and a condenser.

**Stopwater.** A packing of felt or canvas and red lead to prevent water from passing through between metal parts, where caulking is impracticable (in steel ships).

**Stopwater.** A wooden plug, driven through the joint of a keel scarph, etc., to prevent water percolating into the vessel (in wood ships).

**Storm valve.** A check valve in a pipe opening above the water line in a ship.

**Stow.** To stow or pack cargo so that it will not shift as the vessel rolls.

**Stowage.** The proper placing and securing of cargo in a vessel so that it will not shift and produce a dangerous condition or excessive strain.

**Strainer, strum.** A perforated plate, wire cloth or any object fitted to allow the entry or exit of water but preventing the passing of any refuse matter.

**Streak, strake, stroke.** A continuous range of plating or planking extending all fore and aft, or from end to end of a vessel.

**Stringer.** A longitudinal stiffener for the side of a ship, made of angle bar, bulb angle, channel, or plates, etc. See Plate XIII. At first they were considered of great importance, but in modern practice the need for them has been met by making the transverse framing heavier, and sometimes by placing a rubbing strip on the side plating.

**Strum box.** See Rose box.

**Strut.** Strips of flat iron used to brace one part with another.

**Stud.** A pin projecting from or fitted between anything, as the stud of a chain cable link.

**Studbolt, studpin.** A stud threaded at both ends, one end of which is screwed into a fixed part, and having a nut upon the

other end, used for securing cylinder cover, movable propeller blades, etc.

**Stud-link chain.** A chain having a stud across the middle of each link, for extra strength.

**Stuffing box.** A box or fitting round a shaft, rod, etc., packed with some substance to make the aperture in which it moves, steam, air or watertight. See Plate XXXVI.

**Stuffing-box bulkhead.** The after peak bulkhead, so called because the propeller shaft stuffing box is riveted to it. It usually extends to the same height as the collision, stokehold, and engine-room bulkheads. The stern tube is flanged and through this bulkhead to stuffing box.

**Stuffing-box gland.** A piece which retains packing in stuffing box.

**Stuffing-box studs.** Studs which hold gland in position.

**Submarine.** Anything below the surface of the sea; a vessel designed for service beneath the surface of the sea.

**Suction pipe.** A supply pipe to a pump.

**Suction valve.** Any self-acting valve permitting the entry of water, steam, or gases into a pump suction pipe, etc., but preventing its return.

**Sunk forecastle.** A forecastle partly above and partly below the level of an upper deck.

**Sunk poop.** A poop set part way down into the 'tween decks. In a case of this kind the poop deck is but a little above the next deck forward.

**Superheated steam.** Steam of higher temperature than boiler steam. Steam is superheated to get dry steam and greater effectiveness.

**Superheater.** A contrivance for the purpose of superheating the steam, to give it a higher temperature than it had when leaving the boilers, thus depriving it of water held in suspension, before it passes into the main steam pipe on its way to the cylinder.

**Superstructure.** Any structure built above the top full deck, such as deck house, bridge, etc.

**Surface condenser.** A condenser containing a multitude of small copper or brass tubes through which cold water is continuously forced by the circulating pump to condense the steam coming in contact with the outer surface of the tubes. In some cases the steam is passed through the tubes while cooling water circulates about them.

**Swash plate.** A plate fitted in a tank to retard the flow or surge of a liquid cargo or ballast when the ship rolls or pitches.

**Swivel block.** A block having a swivel hook, enabling the block to be turned in any direction.

**Symbols.** Marks of identification. See Appendix.

**Tack, to tack.** To come about; that is, to change direction of sailing with respect to the wind. When a ship is sailing so that the wind striking her sails comes from over her starboard side, she is said to sail on a starboard tack; and when the wind comes over the port side she is said to be sailing on a port tack.

**Taffrail.** The portion of a raised quarter deck rail or main poop rail (as the case may be) round the after end of either.

**Tail end shaft, tail shaft, propeller shaft, screw shaft, stern shaft.** The aftermost length of shafting in a screw steamer, on to the outer end of which the screw propeller is fixed.

**Tail plate.** A plate to cover the rudder port and fitted in halves and secured with hexagon-head bolts to the counter plating so as to be easily removable to permit shifting the rudder for repairs. See Horseshoe plates. See Plate XV.

**Tanks.** Are of two kinds: First those built in permanently, and part of the ship's structure, used for the reception of water ballast, fuel, oil, or liquid cargo; second, those constructed specially, and removable if necessary. These vary greatly in size and shape and the purpose for which they are used. Tanks in boats are built in airtight to give buoyancy and prevent sinking, if capsized.

**Tank top plating.** Plating fitted over the top of the floors. See Plates IX and XXI.

**Tank vessel.** A sailing vessel or steamer specially constructed and installed with tanks for carrying petroleum, etc., in bulk.

**Tap.** To cut threads inside of a hole.

**Tap.** A tool for tapping.

**Tap rivet.** A rivet with screw thread and a counter-sunk head that is provided with a square stud which is chipped off flush after rivet is placed.

**Tarpaulin.** A canvas cover well filled with tar, oil, and paint.

**Taunt.** Spoken of the masts and spars of a vessel when very high.

**Taut.** Stretched tight.

**Tee bulb bar.** A tee bar with bulb on toe of web.

**Tee bulb beam.** A beam made of a tee bulb bar.

**Tee iron, tee bar.** Bar iron with cross-section like letter T. See Plate LIX.

**Telegraph.** An apparatus placed on a bridge or other elevated deck and in communication with the engine room, wheel house, etc., for the purpose of rapidly conveying commands to the engineer. See Plate XXXIII.

**Telltale of a rudder.** An instrument placed on a rudder head, or somewhere in front of the helmsman, to indicate the position of the rudder in the water. See Plate XXXIII.

**Template, templet.** A board cut and marked to show the proper curve of timbers or framing. Also gives form of plates and shapes, the location of holes, etc. Templates are often built up of thin strips of wood or made of heavy paper. See Plate LII.

**Temporary bulkhead.** A bulkhead fitted for temporary purposes.

**Tenon.** Any piece of material so cut as to fit into a mortise.

**Test cocks.** Cocks to ascertain the height of water in a boiler. Three are generally fixed on the back plate, or the water gauge column, one leading into the steam space, one to the ordinary water level, and one below the same.

**Thick strake.** A strake of planking thicker than the neighboring strakes.

**Thick strakes of ceiling.** Strakes of greater thickness than the ordinary ceiling, often fitted in the lower part of the hold, covering the long and short floor heads, for extra strength.

**Thimble.** A small metal eye or ring, concave on its outer diameter, in which a cringle of sail or rope is laid.

**Tholes.** Pegs fitted into holes in a boat's gunwale, and between which oars are placed while rowing.

**Tholeboard.** Short flat pieces of wood fitted on the gunwale of a boat to strengthen the parts into which the rowlocks or the tholepins are inserted.

**Tholepins.** Wooden or iron pins used in place of rowlocks.

**Throat.** That part of a boom or gaff immediately behind the jaws.

**Throttle valve.** A flat disc valve, usually fitted in a main steam-pipe near the valve chest, to shut off the steam from the cylinders or diminish the supply. See Plate XXXV.

**Throttle valve gear.** Levers, rods, spindles, etc., by means of which a throttle valve is opened or shut.

**Throttle valve lever.** A lever by which action is communicated to the throttle valve. See Plate XXXV.

**Throttle valve rod.** A rod connecting throttle to wheel or lever for controlling engine.

**Throttle valve spindle.** The spindle on which the disc in a throttle operates.

**Through fastenings.** Bolts or tree nails driven through both the planks and timbers of a vessel.

**Thrust bearing.** See Thrust block.

**Thrust block.** A bearing for taking up the end thrust of the propeller shaft to keep this end movement off the crankshaft bearings. It is fitted just aft of the engine. See Plate XXXV.

**Thrust collars.** Collars turned up on thrust shaft. See Plate XXXV.

**Thrust recess.** An enlargement of the shaft tunnel at the engine-room bulkhead.

**Thrust shaft.** A section of main line shaft fitted with collars to run in thrust bearing. See Plate XXXV.

**Thrust sheaves.** See Thrust collars.

**Thwart.** Athwart means across, and in a boat the seats are called the thwarts, because they are placed across or athwart the boat.

**Thwartships bunker.** A portion of the main hold or the 'tween-decks of a steamer on the fore side of the stokehold bulkhead, separated from them by a bulkhead extending from side to side of the vessel, used as a spare bunker, or a cargo compartment.

**Tie rod.** A rod serving to tie or hold opposite parts together.

**Tie plank.** A plank used to hold sliding ways until ship is launched.

**Tie plates.** Narrow strips of plate fitted where there is no steel deck to tie the beams together.

**Tiller.** An arm for controlling a rudder. In general use on small boats.

**Tiller ropes.** Ropes to operate tiller.

**Tilt hammer.** A power hammer having a head mounted on the end of a lever, that is raised by a cam and delivers a blow by gravity, usually assisted by the spring of the lever.

**Timbers, ship's.** Any of the timbers used in the building of a vessel, as beams, ribs, floors, etc.

**Toggle.** A wooden pin, usually tapered at both ends, and its middle part spliced into a becket, serving as a key, when passing through the eye of a rope, in the bunghole of a water cask, etc.

**Tomahawk.** A tool used in finishing a rivet.

**Tonnage.** The capacity or the cubical contents of a vessel or any of her compartments or superstructures, one ton being estimated at 100 cubic English feet.

**Top blocks.** Cap blocks or keel blocks placed between wedges and keel.

**Top blocks of main bearings.** Blocks that hold shaft down in bearings.

**Top grating.** The top platform about engine or boiler.

**Top of tank.** The cover of iron or steel plates on a tank. It is always fitted with manholes giving entrance to the interior.

**Topside plating.** The side plating of a vessel above the load line.

**Torpedo.** A steel plug forced through a pipe to expand lead tubing for lining.

**Towboat, tugboat.** A small steamer with powerful engines, specially built for towing vessels.

**Tow rope.** The rope by which the vessel is towed.

**Transmitting shaft, driving shaft.** Any shaft which communicates motion to other shafts or parts of machinery.

**Transoms.** Timbers used in the construction of a square stern, extending in a horizontal direction from "fashion timber" to "fashion timber," and scored into the sternpost (in wood ships).

**Transom plate.** A kind of floor, several being fitted in the upper part of the after extremity of a vessel, and extending from side to side of the stern to support the counter. See Plate XI.

**Transport.** A ship owned or hired by a government to convey troops, horses, military or naval stores, etc., to their place of destination; the conveyance in a vessel of passengers, goods, etc.

**Transverse.** At right angle to the keel.

**Transverse bulkhead.** A bulkhead placed athwartships.

**Travel of a piston.** The distance a piston moves in a cylinder to or fro.

**Trawler.** A fishing vessel with a ground-sweeping net.

**Tread.** The length of a vessel's keel.

**Trend of an anchor.** That part of the shank where its thickness increases, about one-third of its length from the crown.

**Trestletrees.** Flat pieces of wood or steel at a masthead supporting the crosstrees and topmast.

**Trim.** A term used to describe the the state of a vessel as to ballast; the position of a vessel in the water with respect to the horizontal.

**Trimming tanks, peak tanks.** Tanks at the extreme ends of a vessel. By filling or emptying one or the other, a ship may be easily trimmed by the head or stern, as required.

**Triple-expansion engine.** An engine in which the steam expands gradually and successively through three cylinders. First supplied to a high-pressure cylinder; after its use there, passing into an intermediate cylinder at a lower pressure; thence for still further expansion and work into a low-pressure cylinder, and finally to the condenser.

**Triple riveting.** To fasten by three rows of rivets.

**Triping.** A distortion of the web in a frame by the strain put upon it by the plating.

**Trough tool.** A tool for smoothing the edges of an angle.

**Truck.** A small piece of cylindrical shaped wood, placed on the summit of a mast, with a little sheave on one side over which a signal halliard is rove.

**Trundle head.** The circular head of a capstan into which the bars are fixed for turning.

**Trunk cabin.** A cabin half above and half below the upper or spar deck.

**Trunk bulkhead.** A structure of plating which entirely surrounds the engines and boiler openings of a steamer, also the cargo hatchways in some vessels, and extends in height from one deck to another.

**Trunk-deck vessels.** Vessels with a hatchway extending nearly the entire length, fitted with coaming 7 to 9 feet high and decked over. A type of construction used for grain, ore, and occasionally for oil.

**Trunk engine.** An engine with one end of the connecting rod attached to the gudgeon on the inside center of a "trunk," i.e., a large tube encircled by the steam cylinder, through which it has a to-and-fro motion coinciding with that of the piston, to dispense with the use of a piston rod and crosshead.

**Trunk hatchway.** The space enclosed by a trunk bulkhead, fitted between any two hatchways situated vertically to each other.

**Truss.** To truss or truss up is to brail up a sail quickly, which is done with a truss rope or line.

**Tube expander.** An instrument used to expand boiler tubes in a front or back tube plate of a boiler to make them fit close and tight.

**Tube plate.** A plate at or near the end of a boiler, condenser, superheater, etc., with apertures into which the ends of tubes are inserted and fixed. See Plate XXXVII.

**Tube plug stopper.** Any contrivance used to stop a leaky tube in a boiler or condenser.

**Tubular boiler, fire tube boiler.** A boiler in which the tubes are surrounded by water, the heat passing through them.

**Tuck plate.** A flat plate fitted to the sternpost and flanged to take strakes of stern plating.

**Tumbler.** A fitting between the jaws of a gaff to prevent its chafing the mast. Sometimes called a clapper.

**Tumbling blocks.** Blocks inside the eye or quadrant block.

**Tumbling blocks quadrant slippers.** Brass pieces fitted to take the wear of quadrant.

**Tumble home.** The inboard curve of topside plating.

**Tunnel, shaft tunnel.** A watertight structure about 4 to 7 feet in height, somewhat less in breadth, according to the size of the vessel. It extends from engine room to after-peak bulkhead and gives access to the propeller shaft line bearings. See Plate XXXII.

**Tunnel cock or water-service cock.** A cock fitted on the shell plating of a vessel to admit a supply of water from the sea to different parts of the shafting to cool the bearings.

**Tunnel frames.** The curved or half-circular angle bars by

which the tunnel plating is supported, and to which it is riveted, generally spaced 2 to 4 feet apart. See Plate XXXII.

**Tunnel plating.** Plates used in the construction of a shaft tunnel.

**Tunnel recess.** The elevated and extended after portion of a tunnel.

**Turbine.** A form of engine in which all driving parts rotate. There are various types in marine use. See Plates XLIV, LIV-A and LVIII.

**Turbine blading.** Metal blades set in rotator and stator to transform the impact or thrust of the steam into a revolving mechanical motion. See Plate LIV-A.

**Turbine rotator.** The spindle and the discs or drum that turn in a turbine.

**Turbine stator.** The pieces that fit in the casing and hold the stationary blocking.

**Turn.** To pass a rope once or twice or more over a spar or bitts, etc.

**Turning engine.** A small engine used to turn the main engine.

**Turning engine engaging screw.** That part which engages turning engines with main engine. (Better type has two worms and its shaft slides with engagement.)

**Turning-gear wheel.** A wheel mounted on coupling at rear of engine connecting turning engine with main engine. See Plate XXXV.

**Turret ship, turret-deck vessels.** A ship of war in which the heavy guns are mounted on rotating and covered decks called turrets; cargo ships where the sides are rounded in to where the main deck would naturally come and then carried up to a narrow deck, called the turret deck.

**Turtle-back.** The top of a wheelhouse, forecastle, etc., having the form of a turtle's back.

**'Tween-decks ceiling.** The ceiling between any two decks.

**Twine.** Strong thread used in sail-making.

**Two blocks, chock-a-block.** One block hauled close up to another, so that the power they give is destroyed until they are separated.

**Union jack.** In the United States, the blue field with the stars; carried on the jackstaff at the bow. In Great Britain, a blue field with the crosses of St. Andrew, St. George, and St. Stephen.

**Universal joint.** A joint designed so that one shaft or rod can turn another that is not in line with it.

**Upper deck.** The deck above a main deck in a ship, exclusive of bridge-poop, raised-quarter, and forecastle decks.

**Upper sheerstrake, upper-deck sheerstrake.** The strake of outside plating in line with the upper deck.

**Upper stern.** Top part of stern.

**Upper turn of bilge stringer.** Double angle bars or any other form of stringer fitted in the upper turn of the bilge.

**Upper works** (old term). The same as freeboard when a vessel is loaded.

**Uptake.** The part connecting smokebox to funnel. Sometimes the term is used to include the smokebox.

**Valve quadrant.** Steel bars curved on an arc and forming part of reversing gear. See Plate XXXVI.

**Valve stem.** A rod on which a valve operates.

**Valve-stem guide bracket.** A bracket supporting a valve-stem guide. See Plate XXXVI.

**Valve-stem stuffing box.** A stuffing box on end of valve chest through which valve stem works. See Plate XXXVI.

**Vanes or vangs.** Ropes extending from the peak of a gaff, sprit, or lateen yard to the side of a vessel, to steady either of these when hoisted without a sail, as is often the case in square-rigged vessels and steamboats.

**Ventilator.** The arrangement by which fresh air is introduced to, and foul air expelled from, any part of the vessel. Usually constructed in tubular form, of large size and made of sheet iron. See Plates XXXVIII and XXXIX.

**Ventilator turning gear.** The hand wheel, rod, and gear wheel for turning ventilator. See Plate XXXVIII.

**Vertical center keelson.** A keelson of strong vertical plates fitted at the middle line upon a flat plate keel and to which the (half) floor plates are connected by vertical angle bars. See Plate XIX.

**Vessel.** A craft which requires a licensed master (boats do not).

**Voice tube.** A tube between the pilot house and the engine room for speaking purposes.

**Wale.** The wale, or outer wale, of a boat is the strake running beneath and supporting the outer edge of the gunwale, sometimes called the band or the rubbing piece.

**Warp.** A rope lighter than a hawser, but usually the same length. Used for mooring a vessel in port, or for hauling her into some desired position.

**Warping bridge.** A bridge at the after end used while docking ship.

**Wash plates.** Plates fitted vertically between the floors about half-way between the middle line and the bilge, serving to check the wash of bilge water when the vessel is rolling.

**Watches.** The division of a ship's company into two divisions, called the starboard watch and the port watch. A day (24

hours) is divided into periods of four hours, called watches. (From 4 p.m. to 8 p.m. is commonly called the "dog watch.")

**Water ballast.** Sea water used for ballast, let into the double bottom, or into a water-ballast tank.

**Water-ballast tank.** A watertight compartment in a vessel, for the reception of water as ballast, when required.

**Water line** (light). The line to which a vessel is submerged without cargo on board.

**Water line** (loaded). The line to which a vessel is submerged with full cargo. See Plate XVIII.

**Watertight bulkhead.** A bulkhead that will not let water pass from one side of it to the other.

**Watertight compartment.** A compartment having a watertight bulkhead at each end.

**Water tubes.** Tubes used in tubulous boilers, i.e., being surrounded by fire, while through them the water circulates and is converted into steam.

**Water-tube boiler.** A boiler in which the tubes are surrounded by fire while the water circulates through them.

**Waterway.** A gutter at the edge of a deck for draining off water. See Plate XI.

**Way.** A term variously applied, as "headway" when making progress through the water; "getting under way" when starting from one port for another; "sternway" when going backward.

**Ways.** The framework of timber, etc., on which a vessel is built, and from which she is launched into the water.

A. **Ground ways.** Stationary timbers on which sliding ways travel. See Plates XV and XVI.

B. **Sliding ways.** Timbers moving with the ship sliding over the ground ways.

**Weather bow.** The bow side against which the wind is blowing.

**Weather brace.** The brace that runs to the side from which the wind comes; lee (brace) denotes the opposite. Anything on board a ship may be so designated.

**Weather deck.** A deck exposed to the wind and sea, i.e., not fully covered by a deck above with side plating coming up to it.

**Weather quarter.** The quarter against which the wind is blowing.

**Web.** A plate-like section extending between thicker parts.

**Web frame.** A frame built up transversely with a plate or plates to give greater stiffness. See Plate XXVI.

**Web-frame angle bars.** Angle bars fitted on the inside of a web frame.

**Wedges.** Tapered pieces of wood or iron. Used extensively to

force parts into place. See Plates IV and XVI.

**Weeping.** When water oozes through the seams of a vessel's bottom, or a steam boiler, etc., they are said to weep.

**Weigh shaft.** A shaft forming part of the reversing gear to which motion is imparted by the reversing shaft. See Plate XXXVI.

**Weigh-shaft arms.** Arms one end of which are fixed on the weigh shaft, the other being in connection with the draglink, serving to convey the motion of the weigh shaft to the reversing link.

**Welding.** Connecting two separate pieces of steel, iron, or other metal so that they become all one piece. (For Electric and Gas Welding, see Appendix.)

**Well.** That portion of an upper deck (weather deck) between a bridge and a forecastle bulkhead.

**Well-deck vessel.** A vessel having a long poop, or raised quarter deck, and the bridge house combined, and a forecastle; the deepening between these structures forming the "well."

**Wet-bottomed boiler.** A boiler having water space beneath the furnace.

**Wet dock, wet slip.** A dock where vessels float (not a drydock). Here machinery and fittings are put on board and dock trials conducted.

**Whaler.** A ship employed in the whale trade.

**Wharf.** A structure built out from the shore into water deep enough to permit of vessels coming alongside.

**Wheel house.** A house over the wheel. (Found on some large sailing ships and on steamers where the hand steering wheel is on an exposed deck.)

**Whelps.** The projecting ribs on the barrel of a capstan or windlass. They enable the cable to get a good bite.

**Whip.** A rope rove through a single block, used for hoisting or lowering articles of light weight.

**Whistle pull.** A cord in the pilot house to operate the whistle. See Plate XXXII.

**White rope.** A rope in the laying of which no tar has been applied.

**Winch.** A machine used for loading and discharging cargo, or for hauling on lines. Some winches are made to turn by hand; others, by steam or electricity.

**Winch head.** A drum (usually of small diameter and concave) on a winch. Designed for taking and holding the turns of a rope.

**Winch partners.** Angle bars, bulb bars, plates, pieces of timber, etc., fitted fore and aft under the winches.

**Winder.** A tool for pushing a shape around on bending slab.

**Windlass.** A special form of winch used to hoist the anchors. It has two drums designed to grab the links of the anchor cables, and is fitted with ratchet and braking device suitable for "paying out" cable.

**Windlass levers.** Iron bars inserted in the crosshead of a windlass, serving to work the machine by hand power.

**Wing frames.** A term indiscriminately applied to side frames. See Plate XXIV.

**Wing girder.** The girder terminating the side of a wing tank.

**Wing girder plate.** A plate forming part of a wing girder.

**Wing tanks.** Tanks (sometimes called topside tanks) formed by a section of deck and topside plating and a fore-and-aft bulkhead set diagonally from side to deck.

**Wing transom.** The transom upon which the lower stern timbers step, and the one to which they are tenoned.

**Working.** "Working parts," parts of a machine that move. "Working loose," getting loose because of some strain or vibration; as, a rivet works loose, or a nut works off.

**Worm, wormshaft.** A short screw-threaded bar, the threads of which are geared into the teeth of a wheel, which is driven or turned by the revolutions of the bar.

**Wrecking blocks.** Large heavy iron-strapped blocks with lashing shackles, used for rigging up special derricks for temporary use with heavy loads.

**Wrinkling.** Small wave-like deformations in a plate stringer.

**Wyper.** The shaft which operates the valve-lifting arms on a beam engine.

**Yarrow boiler.** A design of boiler invented by A. F. Yarrow. Two heads (cylinders) are connected by small tubes to a steam dome or cylinder, the whole taking the form of a huge inverted "V." Water in the tubes is made into steam by heat applied about the cylinders and tubes.

**Zee bars.** Iron bars with cross-section like letter Z. See Plate LIX.

# APPENDIX I

## A LIST OF SHIPYARD TRADES, AND THE DUTIES PERFORMED BY EACH.

The following list is fairly indicative of the trades employed in steel shipbuilding; the duties will vary somewhat with particular yard organizations.

**Accountants.** Men or women keeping records of material, labor, and production.

**Anglesmiths.** Men forming and shaping the smaller parts of the hull, such as are made of angle iron, channel iron, etc.

**Auditors.** Men or women checking up the costs of the various departments and overhead expenses.

**Blacksmiths.** Men doing a large variety of work in some yard shops, such as tool dressing, case-hardening, tempering, annealing, stamping, pressing, and the heaviest forging. The work varies from making turbine blades to building a rudder post.

**Boilermakers.** Men making Scotch boilers, Yarrow boilers, condensers, tanks, and uptakes.

**Bolters up.** These men follow the "riggers" or assemblers and precede the drillers, reamers, and riveters in the work of building the hull. They force plates and shapes into place and secure them with bolts and nuts so as to make possible drilling, reaming, and riveting.

**Caulkers.** Men making seams and joints water- and oiltight by swaging the metal into the space between the parts. (This is done by special tools driven by compressed air, and is called caulking.)

**Carpenters** (ship). Men building deck houses, when of wood, companionways, furniture, etc.

**Chaisers.** These are men very familiar with all kinds of work done in the department in which they work, and to some extent they must understand the nature of work done by cooperating departments. Their business is to follow up orders and make sure that stock, etc., will be ready when required.

**Chippers.** Men chipping or smoothing up castings, cutting away metal to make a fit on plates or forms, using generally an air chipping hammer.

**Coppersmith.** A marine coppersmith is able to make or shape a large variety of copper pipe and tubing. He must be able to make such things as con-

denser heads and large sizes of pipe from sheet copper.

**Cranemen.** Men operatinng electric cranes on the ways or in the shops.

**Cutters or burners.** Men using acetylene or oxy-hydrogen torches to burn out or cut metal parts.

**Draftsmen.** Men specializing on drafting, such as hull or engine work or electrical installation, etc.

**Electricians.** Men installing on a ship, or in the yard, electrical apparatus and the necessary wires for operation. They also make repairs on electrical equipment. Armored cable, conduit and molding are used, and in many respects a shipyard electrician or wireman will do much the same work as outside electricians.

**Engineers.** Both locomotive and hoist engineers are employed in the handling of shipbuilding material. Stationary engineers operate yard power plants, and marine engineers build and test marine engines.

**Estimators.** On contract work these men make out the contracts for the men and estimate the amount of time required to do the job.

**Foundrymen.** Same as outside foundrymen.

**Furnacemen.** These men heat plates and forms and on a bending floor with tools and templates form plates and shapes for the hull.

**Galvanizers.** Same as outside, except that the pieces galvanized are larger than generally galvanized.

**Heaters.** Generally boys, who heat rivets.

**Holders-on** (buckers up). Men who hold a dollybar or hammer against the head of a rivet which is being "driven."

**Inspectors.** Men selected to inspect and test parts of hull and machinery.

**Layers-Out.** Men laying out the work to be done, i.e., locating holes, lines, etc., on the ship or parts of it.

**Loftsmen.** Men working in a mold loft who "lay down" the lines of a ship full size on the floor and make templates from them.

**Machinists** (inside). Same as machinists in other industries, except that they possibly have a greater variety of work.

**Machinists** (outside). These men install boilers, engines, auxiliary machinery, etc., on ships.

**Packers.** Men placing felt, burlap, or other material in joints to make hull watertight.

**Painters** (as outside).

**Passers.** Boys passing rivets to holders-on.

**Patternmakers** (as outside).

**Pipefitters.** Men fitting and installing steam and water pipes on board ship.

**Pipe coverers** (as outside).

**Plumbers.** Men installing sanitary pipe lines, bath fixtures, etc., on board ship.

**Reamers.** Men making holes ready to receive rivets. They generally use a reamer driven by compressed air.

**Riggers.** Men making and installing the standing and running rigging on a ship. The term is also applied to men who assemble the hull or place heavy parts in position.

**Riveters.** In general, men driving rivets. A snap riveter, one driving snap rivets; flush riveter, one driving flush rivets; bull riveter, one who operates a bull riveting machine.

**Sailmakers.** In a steel shipyard a few sailmakers are employed to make awnings, spray hoods, wind shields, etc.

**Sheet metal workers.** Much as outside, except work is generally more difficult and heavier.

**Shipfitters.** Men able to make and assemble parts of the ship's hull, lift templates, and fit foundations, hatch coamings, etc.

**Shipwrights.** Men doing a great variety of work about the ship. They keep it fair while building, launch her when ready, place masts and booms in position, etc.

**Welders.** Men making a specialty of welding, using either gas or electricity.

# APPENDIX II

## ELECTRIC WELDING

THE art of welding in itself is not new, having been used for a great many years in all classes of work. The first method, which was used for several centuries, was what is termed the blacksmith or forge welding. It consisted of heating the metal until it attained a plastic state, and then the joining of the two metals by hammering them while under this heat. In this way the two metals were united and formed into their proper shape.

When it was found that heat could be attained considerably quicker by use of electricity, the attention of scientists was diverted to the proper designing of machines for applying heat in this way, in place of by the forge method. The various experiments brought out the fact that electricity could be applied to welding in several different forms, and we, therefore, at this day have electric welding, divided into two main methods, namely, the Resistance Welding and Arc Welding.

The Resistance Welding is again subdivided into three distinct branches, called Butt Welding, Spot Welding and Seam Welding.

Again, the Arc method is subdivided into two distinct branches of Carbon Arc Welding and Metal Arc Welding.

The Metal Arc Welding is again divided into a process whereby the bare metal electrode and the covered metal electrode is used. This covered metal electrode is covered with fluxes of two distinct types, namely, a gaseous flux and a liquid flux.

The Resistance type of welding is a very near approach to the original blacksmith welding. The surfaces to be united are approximately fitted, brought into close contact, and an electric current cast of sufficient strength to bring the surfaces to welding heat. Then pressure is applied to force them into contact and to extrude oxides, etc., as far as possible. The heat produced by the passage of the current is greater at the contact surfaces than in the solid metal, because the electric resistance, even through well-fitted surfaces, is much greater than in a similar length of solid metal. The heat is, therefore, localized by this fact, and is further localized by using clamping electrodes, of low resistance, which hold the work as nearly as possible to the weld.

Alternating current is always employed for Resistance Welding, because of the high current at low voltage requisite to produce the proper temperature.

Where time and economy, especially the latter, are essential, electric Arc Welding may be used. The process of striking the Arc by touching the work with the carbon metal electrode and withdrawing it to a distance varying with the current used, is the general principle of Electric Arc Welding.

Instead of carbon, a rod of bare metal, approximately similar in constituence to the metals to be welded, is used to spring the arc. As the arc temperature with metal electrodes is considerably lower than the carbon, there is less risk of burning the metal.

One side of the electric circuit is connected to the work, and the other side goes directly to the bare metal electrode. The nature of the electric current flow drives the molten metal from the electrode to the intersection of the pieces of the metal to be welded together.

We thus have a system which is extremely important to shipbuilding construction, as it is not necessary to lap the plates, and, therefore, a butt weld may be used. This very greatly reduces the amount of material in the construction of the ship.

The projection of the metal from the electrode is so powerful that vertical and overhead welds are readily and safely made, a task which is very difficult with ordinary oxy-acetylene welding. It will be noted that the old original blacksmith method would be absolutely impractical for any work outside of the shop.

On the following pages we illustrate the extent of nomenclature, which has been approved by the classification society as being requisite to the proper and economic describing of Electric Arc Welding by the technician and designer in the drawing rooms.

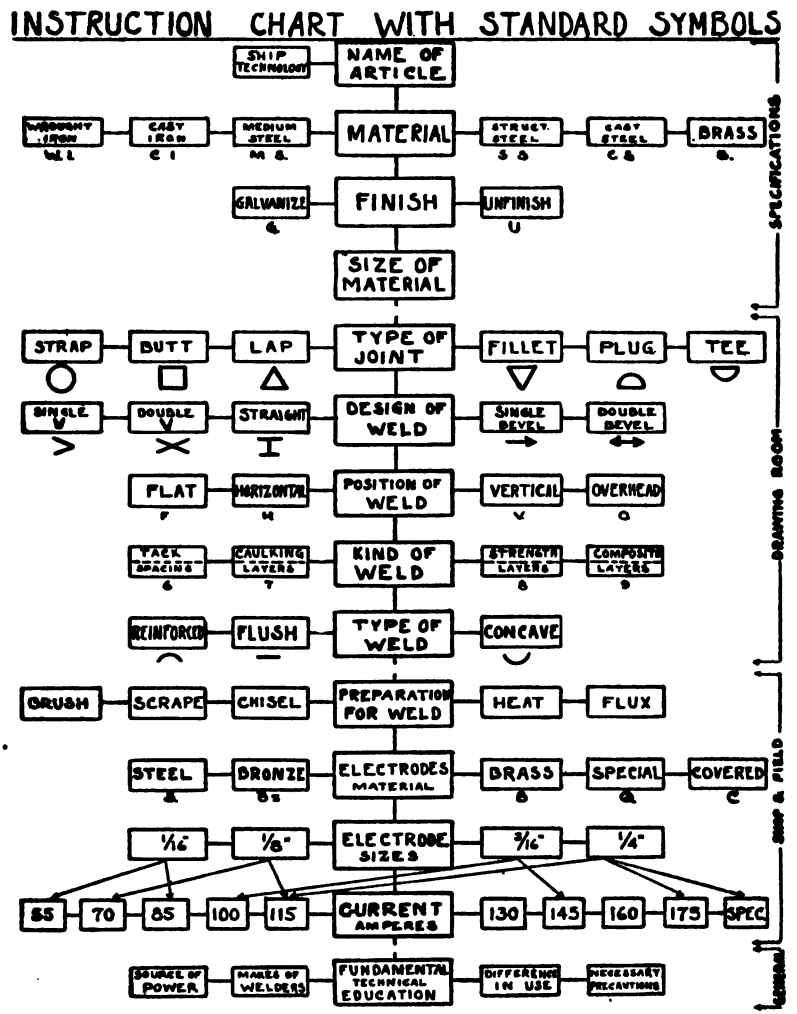
The first sheet headed "Instruction Chart with Standard Symbols" shows the points necessary for consideration in preparing drawings and designs, and also the manner in which these precautions must be considered. It further shows the points necessary in specifications followed by the correct symbols to be used on the blue prints for the purpose of informing the operator of the style of welding which he is to use on the actual production work. It then goes on to show the necessary points to be considered by the operator in the shop and in the field, and lastly the fundamental, technical instructions which every arc welding operator should know before proceeding with the work

From the second to the seventh sheets are illustrations of the various subdivisions of the symbols as used in the draughting room,

with a condensed explanation of each symbol and name given in the chart.

In the last five sheets of illustrations are given, in a condensed form, the combinations that these symbols may be put to for describing welds of almost any and all descriptions. By a very careful study of these various combinations, it will readily be seen that each symbol in itself gives all the information that an operator must have to properly perform his work, and it is essential that the operator, as well as the technician, must know and study these symbols just as carefully as the present day iron worker must know the symbols of the structural department, or the electrician the symbols of the electrical drawing room.

WM. C. SCHRADER.

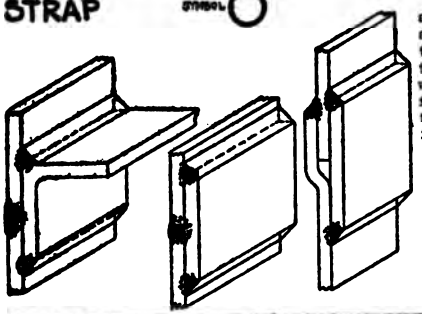



ELECTRIC WELDING—CHART NO. 1.

# TYPE OF JOINT

## STRAP

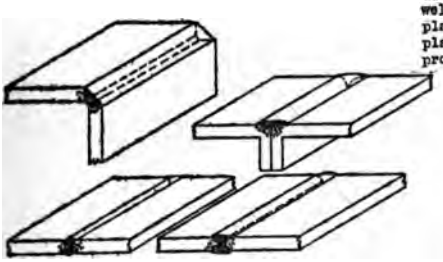
SYMBOL ○



STRAP weld is one in which the seam or two adjoining plates or surfaces is reinforced by any form or shape to add strength and stability to the joint or plate. In this form of weld the seam can only be welded from the side of the work opposite the reinforcement, and the reinforcement of whatever shape must be welded from the side of the work to which the reinforcement is applied.

## BUTT

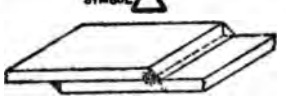
SYMBOL □

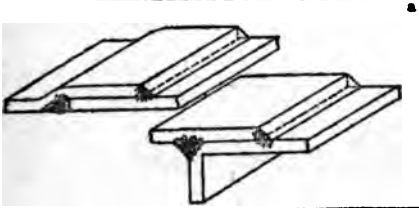


BUTT weld is one in which two plates or surfaces are brought together edge to edge and welded along the seam thus formed. The two plates when so welded, form a perfectly flat plane in themselves excluding the possible projective caused by other individual objects as frames, straps, stiffeners, etc., or the building up of the weld proper.

## LAP

SYMBOL △

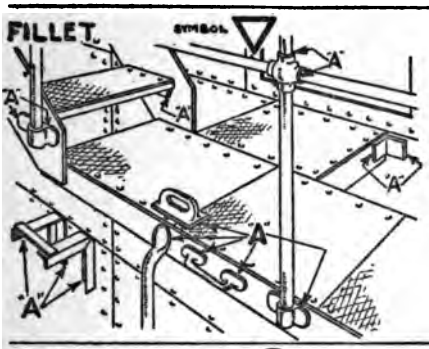




LAP weld is one in which the edges of two plates are set one above the other and the welding material so applied as to bind the edge of one plate to the face of the other plate. In this form of weld the seam or lap forms a raised surface along its entire extent.

# TYPE OF JOINT (CONTINUED)

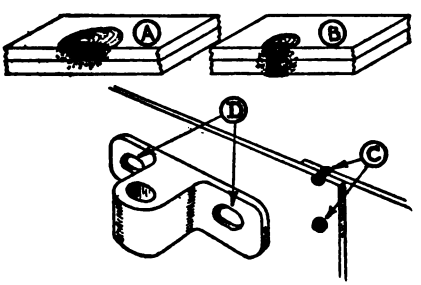
## FILLET




FILLET weld is one in which some fixture or member is welded to the face of a plate, by welding along the vertical edge of the fixture or member (see "welds" shown and marked "A" on illustration at left). The welding material is applied in the corner thus formed and finished at an angle of forty-five degrees to the plate.

## PLUG

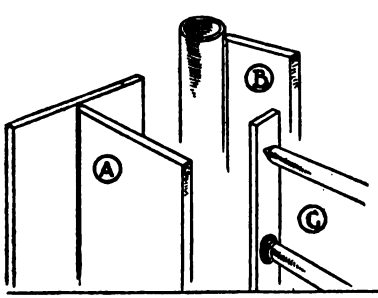
SYMBOL




PLUG weld is one used to connect the metals by welding through a hole in either one plate (Fig. "A") or both plates (Fig. "B"). Also used for filling through a bolt hole as at (Fig. "C"), or for added strength when fastening fixtures to the face of a plate by drilling a countersunk hole through the material (Fig. "D") and applying the welding material through this hole, as at (Fig. "D"), thereby fastening the fixture to the plate at this point.

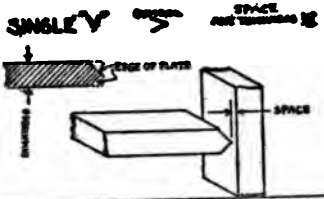
## TEE

SYMBOL

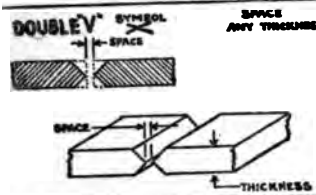



TEE weld is one where one plate is welded vertically to another as in the case of the edge of a transverse bulkhead (Fig. "A") being welded against the shellplating or deck. This is a weld which in all cases requires EXCEPTIONAL care and can only be used where it is possible to work from both sides of the vertical plate. Also used for welding a rod in a vertical position to a flat surface, as the rung of a ladder (Fig. "C"), or a plate welded vertically to a pipe stanchion (Fig. "B"), as in the case of water closet stalls.

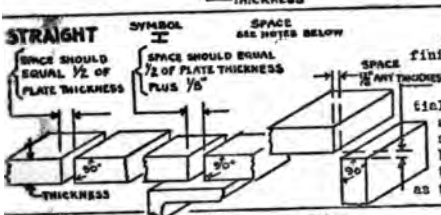
# DESIGN OF WELD



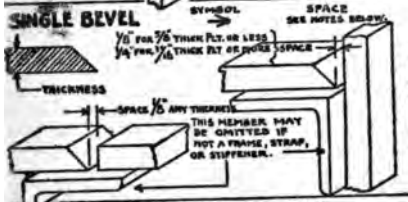

SINGLE "V" is a term applied to the "edge finish" of a plate when this edge is bevelled from BOTH sides to an angle, the degrees of which are left to the designer. To be used when the "V" side of the plate is to be a maximum "strength" weld, with the plate setting vertically to the face of an adjoining member, and only when the electrode can be applied from both sides of the work.



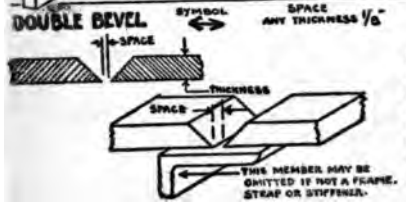

DOUBLE "V" is a term applied to the "edge finish" of two adjoining plates when the adjoining edges of both plates are bevelled from BOTH sides to an angle, the degrees of which are left to the designer. To be used when the two plates are to be "butted" together along these two sides for a maximum "strength" weld. Only to be used when welding can be performed from both sides of the plate.




STRAIGHT is a term applied to the "edge finish" of a plate, when this edge is left in its crude or sheared state. To be used only where maximum strength is NOT essential, or unless used in connection with strap, stiffener or frame, or where it is impossible to otherwise finish the edge. Also to be used for a "strength" weld, when edges of two plates set vertically to each other,—as the edge of a box.

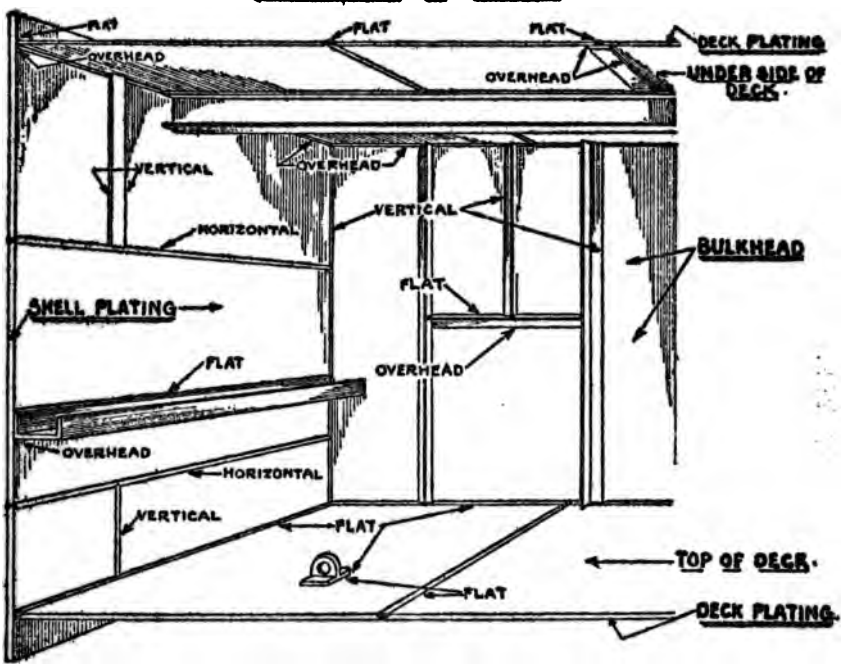



SINGLE BEVEL is a term applied to the edge finish of a plate, when this edge is bevelled from ONE side only to an angle, the degrees of which are left to the designer. To be used for "strength" welding, when the electrode can be applied from ONE side of the plate only, or where it is impossible to finish the adjoining welding surface.




DOUBLE BEVEL is a term applied to the edge finish of two adjoining plates, when the adjoining edges of both plates are bevelled from ONE side only to an angle, the degrees of which are left to the designer. To be used where maximum strength is required, and where electrode can be applied from ONE side of the work only.

# POSITION OF WELD




FLAT position is determined when the welding material is applied to a surface on the same plane as the deck, allowing the electrode to be held in an upright or vertical position. The welding surface may be entirely on a plane with the deck, or one side may be vertical to the deck and welded to an adjoining member that is on a plane with the deck.

HORIZONTAL position is determined when the welding material is applied to a seam or opening, the plane of which is vertical to the deck and the line of weld is parallel with the deck, allowing the electrode to be held in an inboard or outboard position.

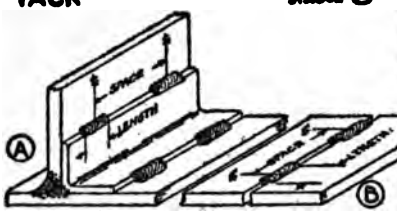
VERTICAL position is determined when the welding material is applied to a surface or seam, whose line extends in a direction from one deck to the deck above, regardless of whether the adjoining members are on a single plane or at an angle to each other. In this position of weld, the electrode would also be held in a partially horizontal position to the work.

OVERHEAD position is determined when the welding material is applied from the under side of any member whose plane is parallel to the deck and necessitates the electrode being held in a downright or inverted position.

# KIND · OF · WELD .

## TACK

SYMBOL · 6 ·

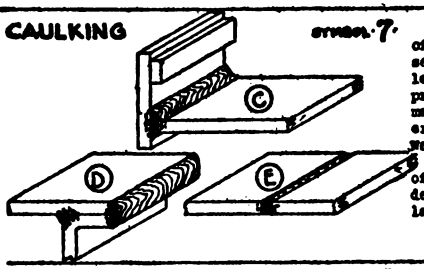



A TACK weld is applying the welding material in small sections to hold two edges together, and should always be specified by giving the SPACE from center to center of weld and the LENGTH of the weld itself. No particular "Design of weld" is necessary of consideration.

A TACK is also used for temporarily holding material in place that is to be solidly welded, until the proper alignment and position is obtained, and in this case, neither the LENGTH, SPACE, or DESIGN OF WELD are to be specified.

## CAULKING

SYMBOL · 7 ·

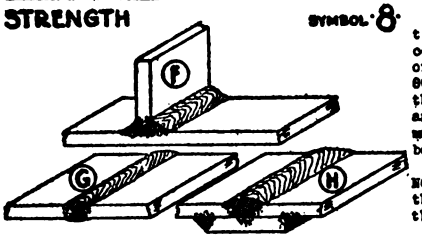



A CAULKING weld is one in which the density of the crystaline metal, used to close up the seam or opening, is such, that no possible leakage is visible under a water, oil or air pressure of 25 lbs. per square inch. The ultimate strength of a caulking weld is not of material importance,- neither is the "Design of Weld" of this kind necessary of consideration.

The operator must be the judge in the number of layers needed for a tight weld, although the designer should specify a minimum amount of layers.

## STRENGTH

SYMBOL · 8 ·

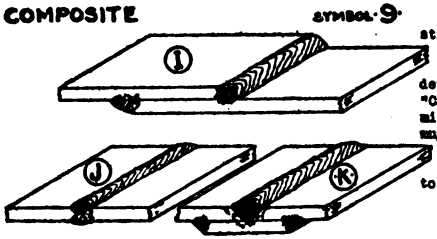



A STRENGTH weld is one in which the sectional area of the welding material must be so considered that its tensile strength and elongation per square inch must be equal at least 80% of the ultimate strength per square inch of the surrounding material. (To be determined and specified by the designer). The welding material can be applied in any number of layers beyond a minimum specified by the designer.

The density of the crystaline metals is NOT of vital importance. In this form of weld, the "Design of weld" must be specified by the designer and followed by the operator.

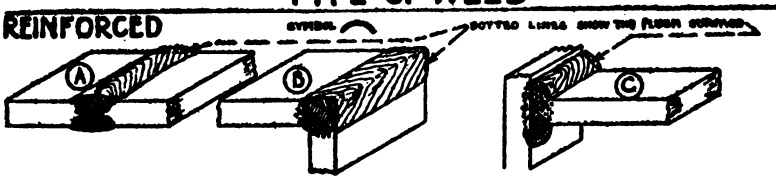
## COMPOSITE

SYMBOL · 9 ·

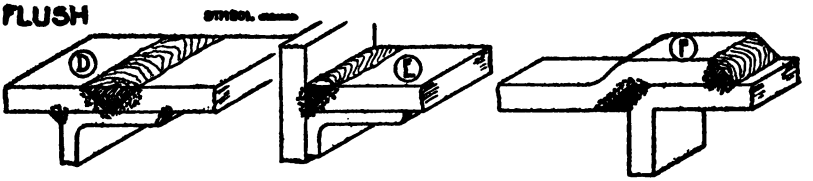



A COMPOSITE weld is one in which both the strength and density are of the most vital importance. The STRENGTH must be at least as specified for a "strength weld", and the density must meet the requirements of a "Caulking weld" both as above defined. The minimum number of layers of welding material must always be specified by the designer, but the welder must be in a position to know if this number must be increased according to the welder's working conditions.

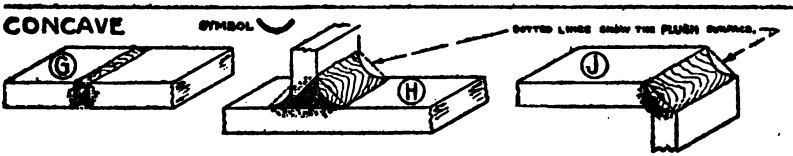
## TYPE OF WELD




REINFORCED is a term applied to a weld when the top layer of the welding material is built up above the plane of the surrounding material as at Fig. "A" or Fig. "B" above, or when used for a corner as in Fig. "C". The top of final layer should project above a plane of 45 degrees to the adjoining material. This 45 degrees line is shown "dotted" in Fig."C" above. This type is chiefly used in a "Strength" or "Composite" kind of weld for the purpose of obtaining the maximum strength efficiency. and should be specified by the designer, together with a minimum number of layers of welding material.



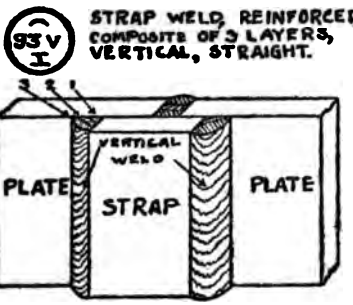

FLUSH is a term applied to a weld when the top layer is finished perfectly flat or on the same plane as on the adjoining material as shown at Figs. "D" and "E" above or at an angle of 45 degrees when used to connect two surfaces at an angle to each other as at Fig. "F" above. This type of weld is to be used where a maximum tensile strength is not all important and must be specified by the designer, together with a minimum number of layers of welding material.



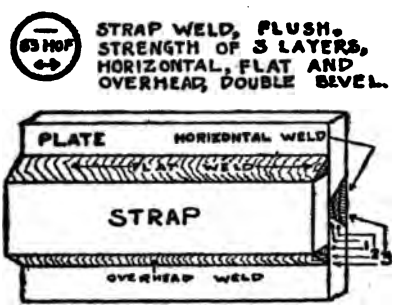

CONCAVE is a term applied to a weld when the top layer finishes below the plane of the surrounding material as at Fig. "G" above, or beneath a plane of 45 degrees at an angular connection as at Figs. "H" and "J" above.

To be used as a weld of no further importance than filling in a seam or opening, or for strictly caulking purposes, when it is found that a minimum amount of welding material will suffice to sustain a specified pound square inch pressure without leakage. In this "Type of weld" it will not be necessary for the designer ordinarily to specify the number of layers of material owing to the lack of structural importance.

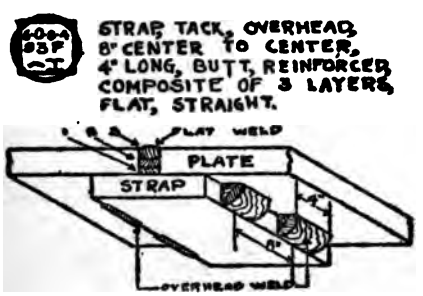
# COMBINATIONS OF SYMBOLS.




This sketch and symbol shows a strap holding two plates together, setting vertically, with the welding material applied in not less than three layers at each edge of the strap, as well as between the plates with a reinforced composite finish, so as to make the welded seams absolutely water, air or oiltight, and to attain the maximum tenaile strength. The edges of the strap and the plates are left in a natural or sheared finish. This type of welding is used for most particular kind of work where maximum strains are to be sustained.



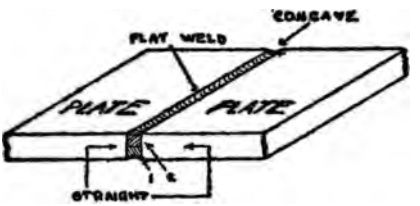

This illustrations shows a strap holding two plates together horizontally, welded as a strength member with a minimum of three layers and a flush finish. Inasmuch as the strap necessitates welding of the plates from one side only, both edges of the plates are bevelled to an angle, the degrees of which are left to the discretion of the designer. The edges of the strap are left in a natural or sheared state, and the maximum strength is attained by the mode of applying the welding material, and through the sectional area per square inch exceeding the sectional area of the surrounding material.




This symbol represents two plates butted together and welded flat, with a composite weld of not less than three layers, and a reinforced finish. A strap is attached by means of overhead tacking, the tacks being four inches long and spaced eight inches from center to center. In this case, the welding of the plates is of maximum strength and water, air or oiltight, but the tacking is either for the purpose of holding the strap in place until it may be continuously welded, or because strength is not essential. All the edges are left in their natural or sheared state.

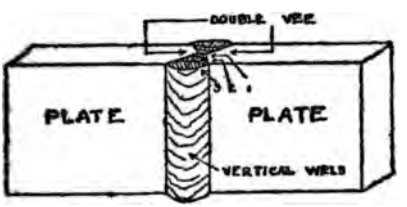
## COMBINATIONS OF SYMBOLS (continued)

### BUTT WELD, CONCAVE, CAULKING OF 2 LAYERS, FLAT STRAIGHT



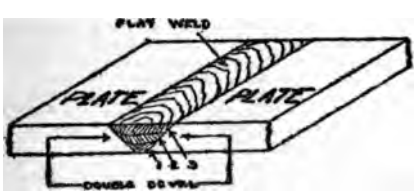

The symbol shown represents a Butt Weld between two plates with the welding material finished concaved and applied in a minimum of two layers to take the place of caulking. The edges of the plates are left in a natural shear cut finish. This Symbol will be quite frequently used for deck plating or any other place where strength is not essential, but where the material must be water, air or oiltight.

### BUTT WELD, REINFORCED, STRENGTH OF 3 LAYERS, VERTICAL, DOUBLE VEE.




This Symbol is used where the edges of two plates are vertically butted together and welded as a strength member. The edges of the adjoining plates are finished with a "Double Vee" and the minimum of three layers of welding material applied from each side, finished with a convex surface, thereby making the sectional area per square inch of the weld, greater than that of the plates. This will be a conventional Symbol for shell plating or any other members requiring a maximum tensile strength, where the welding can be done from both sides of the work.

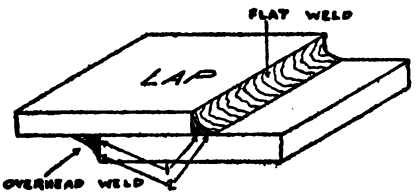
### BUTT WELD, FLUSH, COMPOSITE OF 3 LAYERS, FLAT, DOUBLE BEVEL




This Symbol shows two plates butted together in a flat position where the welding can only be applied from the top surface. It shows a weld required for plating where both strength and watertightness are to be considered. The welding material is applied in a minimum of three layers and finished flush with the level of the plates. Both edges of the adjoining plates are bevelled to an angle, the degrees of which are left to the discretion and judgment of the designer, and should only be used when it is impossible to weld from both sides of the work.

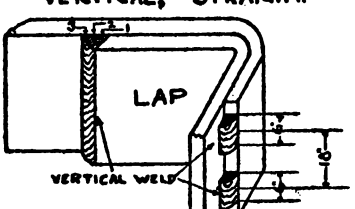
## COMBINATIONS · OF · SYMBOLS · (CONTINUED).

### LAP WELD, CONCAVE, CAULKING OF 2 LAYERS, OVERHEAD AND FLAT, STRAIGHT.



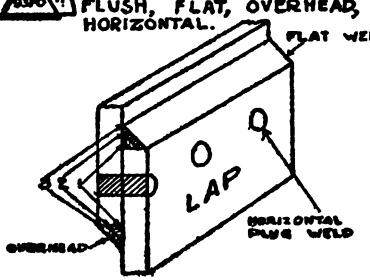

The sketch shows the edges of two plates lapping each other with the welding material applied in not less than two layers at each edge, with a concaved caulking finish, so applied as to make the welded seams absolutely water, air, or oiltight. The edges of the plates themselves are left in a natural or sheared finish. Conditions of this kind will often occur around bulkhead door frames where maximum strength is not absolutely essential.

### LAP WELD, REINFORCED STRENGTH OF 3 LAYERS AND TACKING, 18" CENTER TO CENTER, 6" LONG, VERTICAL, STRAIGHT.




The illustration herein shown, is somewhat exaggerated as regards the bending of the plates, but it is only shown this way to fully illustrate the tack and continuous weld. It shows the edges of the plates lapped with one edge welded with a continuous weld of a minimum of three layers with a reinforced finish, thereby giving a maximum tensile strength to the weld, and the other edge of the plate, tack welded. The tacks are six inches long with a space of 12 inches between the welds or 18 inches from center to center of welds. In both cases, the edges of plates are left in a natural or sheared state.

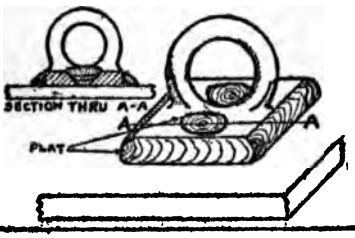
### PLUG AND LAP WELD, STRENGTH OF 3 LAYERS, FLUSH, FLAT, OVERHEAD, HORIZONTAL.




The sketch shows a condition exaggerated, which is apt to occur in side plating where the plates were held in position with bolts for the purpose of alignment before being welded. The edges are to be welded with a minimum of three layers of welding material for a strength weld and finished flush, and after the bolts are removed, the holes thus left are to be filled in with welding material in a manner prescribed for strength welding. The edges of the plates are to be left in a natural or sheared state, which is customary in most cases of lapped welding.

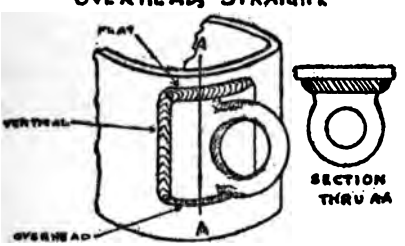
## COMBINATIONS · OF · SYMBOLS · (continued).

### PLUG AND FILLET WELD REINFORCED, STRENGTH OF 3 LAYERS, FLAT, SINGLE BEVEL, AND STRAIGHT



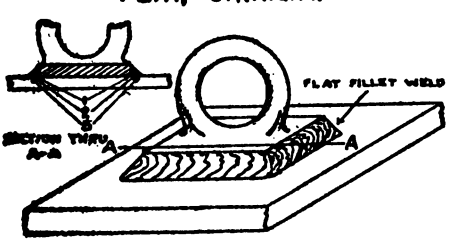

The adjoining sketch shows a pad eye attached to a plate by means of a fillet weld along the edge of the fixture, and further strengthened by plug welds in two countersunk holes drilled in the fixture. The welding material is applied in a flat position for a strength weld with a minimum of three layers and a reinforced finish. The edges of the holes are beveled to an angle, which is left to the judgment of the designer, but the edges of the fixture are left in their natural state. This method is used in fastening fixtures, clips or accessories that would be subjected to an excessive strain or vibration.

### FILLET WELD REINFORCED, COMPOSITE OF 3 LAYERS, FLAT, VERTICAL AND OVERHEAD, STRAIGHT




This illustration shows a fixture attached to a plate by means of a composite weld of not less than three layers with a reinforced finish. The fixture being placed vertically, necessitates a combination of flat, vertical and overhead welding in the course of its erection. Although a fixture of this kind would never be required to be watertight, the composite symbol is simply as a possibility of a combination.

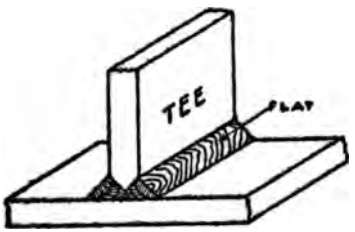
### FILLET WELD, FLUSH, STRENGTH OF 3 LAYERS, FLAT, STRAIGHT.




This symbol represents a fixture attached to a plate by a strength fillet weld of not less than three layers, finished flush. The edges of the fixture are left in their natural state, and the welding material applied in the corner formed by the vertical edge of the fixture in contact with the face of the plate.

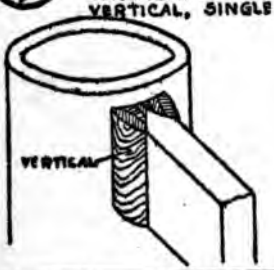
## COMBINATIONS OF SYMBOLS (CONTINUED)

TEE WELD, FLUSH, STRENGTH OF 3 LAYERS, FLAT, SINGLE VEE.



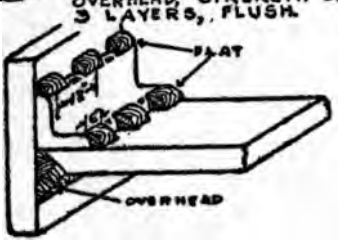

The adjoining sketch illustrates the edge of a plate welded to the face of another plate, as in the case of the bottom of a transverse bulkhead being welded against the deck plating. To obtain a maximum tensile strength at the joint, the edge of the plate is cut to a "Single Vee" and welded on both sides with a strength weld of not less than three layers, and finished flush. This would be a convenient way of fastening the intercostals to the keelsons. In this particular case, the welding is done in a flat position.

TEE WELD, REINFORCED, STRENGTH OF 3 LAYERS, VERTICAL, SINGLE VEE.




This symbol shows another case of Tee weld with the seam setting in a vertical position, and the welding material applied from both sides of the work. The edge of the plate is finished with a "Single Vee" and a minimum of three layers of welding material is applied from each side, finished with a convex surface, thereby making the sectional area, per square inch of the weld, greater than that of the plate, allowing for a maximum tensile strength in the weld.

STRAP AND TEE WELD, FLAT, REINFORCED, TACK, 12" CENTER TO CENTER, 6" LONG, SINGLE BEVEL, OVERHEAD, STRENGTH OF 3 LAYERS, FLUSH.




The illustration herein shown, represents an example of the possible combination of symbols. An angle iron is tack welded to the plate in the form of a strap or stiffener, though in actual practice, this might never occur. The tacks are spaced twelve inches from center to center, and are six inches long, and applied in a flat position, with a reinforced finish. As the strap prevents welding the plate from both sides, the edge of the plate is bevelled, and the welding material applied for strength in not less than three layers in an overhead position and finished flush. Note that in specifying tack welds, it is essential to give the space from center to center of weld, and length of weld by use of figures representing inches placed either side of the circumscribing symbol of the combination.

# APPENDIX III

*Symbols* are used on blue prints, templates, and parts to give location, name, and operation. Some yards have an elaborate system for marking up the work, but as no two yards are alike, only those symbols most commonly used are given.

## SYMBOLS

| | |
|---|---|
| Æ | After end |
| AFT. | Aft. |
| ⊗ | Amidships |
| A.P. | After perpendicular |
| Bhd. | Bulkhead |
| B. H. | Breast hook |
| B. K. | Bilge keel |
| B. L. | Bend line |
| ⊕ | Base line |
| Br'k't or Bkt. | Bracket |
| Circ. | Circumference |
| Ck. | Countersink |
| Ck.M. | Check mark |
| ℄ | Center line |
| C't'r. | Center |
| C't's'k. | Countersink |
| C. V. K. | Center vertical keelson |
| D'b'l. | Double |
| Dia. | Diameter |
| D'k. | Deck |
| Dr. | Drill |
| Drg. | Drawing |
| F'c'le | Forecastle |
| F'd'n | Foundation |
| F. E. | Forward end |
| Fl. | Floor or floor plate |
| Flg. | Flange |
| Fwd. | Forward |
| F. P. | Forward perpendicular |
| Fr. | Frame |
| F. W. T. | Fresh water tanks |
| H. G. | Hatch girder |
| Int'c'l | Intercostal |
| Inter'm | Intermediate |

| | |
|---|---|
| Jog. | Joggle |
| Longt. | Longitudinal |
| Lr. | Lower |
| M. | Main |
| M. C. S. | Machinery casing sides |
| M. C. T. | Machinery casing top |
| M. Dk. | Main deck |
| M'l'd | Molded |
| O. B. | Outboard |
| O. S. | Other side |
| O. S. U. | Other side up |
| O.T. | Oiltight |
| P. | Port |
| P. Dk. | Poop deck |
| Plat. | Platform |
| Pn. | Plane |
| Pu. | Punch |
| Rad. | Radius |
| Rev. | Reverse |
| Riv. | Rivet |
| Roll | Roll |
| S. | Starboard |
| S.B.S. | Shell butt strap |
| S.C.F. | Stern cant frame |
| Sch. | Scarph |
| S'g'l | Single |
| Sh. | Shell |
| Shr. | Shear |
| S.I.K. | Side intercostal keelson |
| S. Pl. | Swash plates |
| S. R. | Shaft recess |
| S. T. | Shaft tunnel |
| Stiff. | Stiffener |
| Tap | Tap |
| Trans. | Transversal |
| T.S. | This side |
| T.S.U. | This side up |
| T.T. | Tank top |
| T.T.L. | Tank top liners |
| U. Dk. | Upper deck |
| Vert'l | Vertical |
| V. K. | Vertical keel |
| W. T. | Watertight |

# APPENDIX IV

## THE ISHERWOOD SYSTEM OF SHIPBUILDING

In order to get a background for a consideration of the Isherwood system, let us review briefly the ordinary system of ship construction and the reasons why ships are so built. We can readily understand how quickly a canvas canoe would close in on us if we attempted to use it without the wooden ribs that extend from side to side. The frames of the ship are for the purpose of resisting just such a pressure on an enormous scale, and because they are at right angles to the center line of the ship, they are called transverse frames. They are secured at their lower ends to the vertical keel or center keelson, and at the upper ends to the deck beams. They are in two parts, called floors and side frames, and are generally spaced from two to three feet apart.

Without going into details concerning such parts as margin plates, side stringers, brackets, etc., it is evident that while absolutely necessary, these frames do subtract from the space enclosed by a ship's skin, i.e., they reduce the available cargo space.

The second principal strain that a ship is subjected to is caused by the unequal and varying support given by the sea. This would cause her to "hump up" first, like some four-wheeled trolley cars, and then bend down like a buckboard, i.e., if she lacked sufficient longitudinal strength. In regular construction this strength is obtained through the keel, keelsons, intercostals (these are called longitudinals), tank top, and decks. The side plating is also called upon to take care of a large amount of this strain that tends to "break the back" of a ship.

The Isherwood plan differs from this construction, first, in placing very heavy transverse members about 12 feet apart, and, second, in using a large number of longitudinal frames for holding the shell plating. A study of Plates LXIII and LXV and a comparison with Plate LXIV will make clear the principal differences found in the two systems. The side longitudinals pass through notches cut in the transverses and are clipped to them. In Plate LXIII it will be seen that the bottom longitudinals are cut in way of the transverses. They are sometimes made continuous between transverse bulkheads. The transverses are connected to the shell plating with heavy angles, and in case of a tank top are cut at the margin plate. Here the strength

is made good by strong tie bars extending from the face angle on the transverses to the tank-top plating (note this on Plate LXV). Under the tank top the transverses are much like an ordinary floor plate except that notches are cut to pass the bottom and tank-top longitudinals. The deck longitudinals furnish one of the greatest advantages offered by this system. They furnish ample longitudinal strength and are not affected by large hatch openings.

For certain kinds of cargo, such as lumber and general freight, the heavy transverses are considered objectionable, as they make for broken stowage, but for bulk and liquid cargoes this type of construction is ideal.

Further information is presented in the following quotation of a paper read by Mr. J. W. Isherwood and printed in *Fairplay*, March 26, 1918:

"I had an inquiry from a large firm of shipowners for an Isherwood cargo boat to carry 16,500 tons dead weight and with the same internal capacity for long timber inside the face of the transverses as in the transversely-built ship to the inside of the cargo battens. This could be obtained either by increasing the length, breadth, or depth, or a combination of all three dimensions. The one that will probably appeal to you most is the one of increased length. The original dimensions were 525 feet by 66 feet by 44 feet, dead weight 16,500 tons on 31 feet. The weight of iron and steel in this vessel built on the ordinary system was about 4750 tons. The dead weight of the Isherwood ship of the same dimensions was 16,900 tons on the same draught and co-efficient, the weight of iron and steel being about 4370 tons, showing a saving in iron and steel of 380 tons and increased dead weight of 400 tons, the difference in dead weight being made up of the reduction in weight of cement. With the length increased to give the required capacity for long timber, the dimensions were 540 feet by 66 feet by 44 feet, being an increase in length of 15 feet, the dead weight 17,400 tons on 31 feet with the same co-efficient, the iron and steel amounting to 4550 tons, being still 200 tons less than in the ordinary vessel of smaller dimensions, whilst the dead weight is increased by 900 tons.

"For the purpose of comparison, I will take as a basis a ship constructed on my system in 1911. The dimensions are 410 feet by 52 feet by 32 feet. The weight of iron and steel in this vessel was 2150 tons; the dead weight 8860 tons, on a draught of 26 feet with a co-efficient of displacement of .76. In a steamer conforming to the same particulars but constructed on the ordinary transverse system, the iron and steel weight amounts to 2370 tons; the dead weight 8620 tons on the same draught and co-efficient, showing a reduction in the dead

weight of 240 tons. Now take the Isherwood vessel and make an addition of 10 per cent., equals 41 feet in the length, bringing this up to 451 feet. The weight of iron and steel would now be 2445 tons, and the dead weight 9720 tons on the same draught. An investigation of the strength shows that the Isherwood ship of the increased length is 6½ per cent. stronger longitudinally than the shorter ship on the ordinary system. I feel sure that the extraordinary commercial possibilities made feasible by this suggestion will appeal to you, as the lengthened vessel fitted with the same engines would steam on the same coal consumption at practically the same speed as the shorter vessel, whilst carrying some 1000 tons more dead weight, at the expense of 75 tons of steel and, of course, the additional outfit required for the larger ship. Further, the extra cubic capacity introduced is just where it is most valuable, namely, in the middle of the ship."

One other feature found in the Isherwood ship is lack of vibration. This is, of course, of particular interest to those concerned with passenger steamers. The system is becoming extensively used in this country. Mr. J. W. Isherwood is a British shipbuilder, and the one whose business and engineering ability made the system a success.

# APPENDIX V

## THE USE OF ACETYLENE, HYDROGEN AND OXYGEN FOR CUTTING AND WELDING

AUTOGENOUS welding by means of the oxy-acetylene torch was developed in France in 1900 by Edmund Fouché and Picard. For about five years little was done commercially; but since 1900, and especially during the last five years, tremendous progress has been made.

In the manufacture and repair of automobiles, boilers, tanks, pipes, metal furniture, etc., etc., the use of the "burner" has become quite familiar. Recently our shipbuilders have awakened to some of the possibilities offered them by the "gas men." They are rapidly passing beyond the idea that the torch is good only for emergency work and repairs, and are constantly finding new uses for it in ship-construction work.

Two factors have contributed to this progress; first, the cheaper production of the gas, and, second, the application of machine-guided torches.

In cutting, as high as fifty per cent. economy is effected by the use of special machines; and not only that, but such a finish is obtained that in many cases no further machining is necessary.

Oxygen is, of course, the cutting agent and chief expense factor, whether acetylene, hydrogen, coal gas, or any other gas is used for heating purposes. It is the steady and even progress of the machine-driven torch that makes for the economic use of the oxygen. On plates XLVII, LXVI, and LXVII are shown three types of machine torches. A hand torch is shown on Plate XLVI.

An interesting feature is, that the machines are portable, and when heavy and irregularly shaped pieces are to be cut the work can be done without moving them. In shipyard work this feature is becoming more and more appreciated.

It should be said that the art is, comparatively, very new and offers to engineering students and enterprising mechanics some wonderful opportunities.

Proficiency in the art of oxy-acetylene welding and cutting is difficult to acquire from printed instructions. Personal instruction is very desirable.

When personal instruction is not available, a skilled and resourceful mechanic, familiar with metals and metal working, should be selected for the oxy-acetylene operator. Many operators have attained considerable efficiency through their own intelligence, resourcefulness, and experience.

## The Apparatus

For stationary installations, the regulators or reducing valves are connected to the pipe line, and for portable outfits they are connected direct to the portable tanks. The regulators reduce the high storage-tank or pipe-line pressure to the lower working pressure, which is adjusted with the regulator to the required pressure for each size of welding or cutting tip. Each regulator has a high-pressure gauge which records the supply pressure, and a low-pressure gauge for the required working pressure. When acetylene is supplied by a generator and pipe line, only the working pressure gauge is required on the acetylene regulator.

Fine threads are used for the oxygen hose connections to both torch and regulator, and coarse threads for the acetylene connections, so that the hose will not be interchangeable.

When portable acetylene and oxygen tanks are used, they should be placed so they will not fall over or be banged against each other, avoiding danger of breaking the regulators or tank valves, and in field work it is practical to lay them on the ground.

Oxygen is usually compressed for welding and cutting service at about 1800 pounds pressure, and care should be taken to open the tank valve slowly so as not to permit the full pressure to rush suddenly into the regulator. A little care in this respect will protect the high-pressure gauge from damage, and a little carelessness will put it out of commission within a short time. No gauge can be made to withstand the continual sudden impact of 1800 pounds pressure.

The acetylene in portable tanks is dissolved in acetone under pressure, and the acetylene should not be drawn from the tank at a rate of more than one-seventh the tank capacity per hour; otherwise acetone will be drawn off with the acetylene, which will be detrimental to the weld. Learn the capacity of the acetylene tank used, and of the size of welding tip to be employed, and be governed accordingly. If it is desired to use acetylene at a faster rate than one tank can supply, connect two or more tanks with a manifold, using a reducing valve for each tank. When through with tanks, always close the tank valves when the regulators are removed.

The beginner should first thoroughly familiarize himself with the oxygen and acetylene generating apparatus and follow implicity the directions for installation and operation attached thereto.

He should learn the correct operation of the regulators, noting carefully the instructions given on the attached tags, so that he can apply the proper gas pressures as shown by the table included in the torch box.

When both oxygen and acetylene are in readiness for operation, he should properly connect the regulators and torch, seeing that these are

no leaks, and that the torch tip is of the proper size to weld the metal with which he begins to experiment, as given in the table.

He must be careful, when seating tips in the torch-head, to screw them in until the conical seat fits tightly; otherwise some of the oxygen may pass into the acetylene chamber surrounding the head of the tip and produce an imperfect gas mixture, which would result in a defective weld.

It is absolutely necessary that the oxy-acetylene flame be accurately adjusted. Too much oxygen will oxidize the metal, and too much acetylene will carburet it, either excess being fatal to the best work. The strength of the weld will not be injured quite so much by a slight excess of acetylene as it will by an excess of oxygen, but only the clearly outlined flame is just right.

### Lighting the Torch and Regulating the Flame

The following instructions must be strictly adhered to if the best results are desired:

1—See that the oxygen regulator and tank valve connections are free from oil, grease, or dirt. Open up the oxygen tank valve slowly so that oxygen will just issue, then close again gently. This is to insure the easy opening of the valve after the regulator is attached, which otherwise might be damaged.

2—Connect the regulator to the tank or service pipe, noting carefully the instructions on tag attached to regulator. See that both regulator adjusting screws are turned back until the spring pressure is no longer felt, and also that both needle valves on the torch are closed.

3—Open the oxygen tank valve *very slowly* and continue to unscrew it until it cannot be unscrewed any further (to prevent leak around spindle). If a new tank is used the tank pressure gauge (large gauge) will record a pressure of about 1800 pounds per square inch, varying slightly according to temperature.

4—Open the oxygen needle valve (upper valve) on the torch.

5—Turn in the oxygen regulator adjusting screw. The torch pressure gauge (small gauge) will then indicate working pressure. Adjust this to two pounds above that shown in tables (page 141) for the tip being used (the two pounds extra pressure will allow for adjustment for drop caused by lowering of pressure in tank, variations in gauges, or other local causes).*

6—Shut off oxygen needle valve on torch.

---

* The pressures given in the table are correct for the different tips. Each tip is tested to this pressure before being sealed in carton. It is more convenient in operation, however, *to have* this excess pressure for adjustment instead of resetting oxygen regulator to deliver *the correct pressure.*

7—Turn on acetylene needle valve on torch (lower valve).

8—Turn on acetylene at source of supply (pipe line or tank).

9—Turn in the acetylene regulator adjusting screw until the pressure given by the tables for the size of tip being used is recorded.

10—Light the gas issuing from the tip. This will give a long white smoky flame of comparatively low temperature.

11—Slowly open the oxygen needle valve on the torch. This will gradually reduce the size of flame, the outer end (the envelope) becoming less luminous and the tip end more so until the luminous portion at the tip assumes a clear outline without any ragged edges (the cone).

12—When this is obtained, again turn off the oxygen slightly until a shadowy point shows from the cone. Then with extreme care turn on the oxygen again until this shadowy point just disappears into the cone. This, with the type of mixing device used in Davis-Bournonville torches, gives the correct flame (temperature 6300 degrees Fahr.), which in the Davis-Bournonville torch is neither oxidizing nor carbonizing and in this torch uses as close to the theoretically correct proportion of the two gases as is obtainable.*

13—From time to time test the correctness of the adjustment by the method indicated under 12 so as to be sure that no change has taken place due to change of temperature or to the drop in pressure of the oxygen in the tank (all regulators change slightly due to this). A slight excess of oxygen pressure will not readily show in the flame and can only be discovered by this test.

## Operation of Torch

In operation, the point of the white cone should be held from 1/16 to ¼ inch from the metal being welded, dependent upon the size of the tip in use, care being taken to hold the torch steadily, as touching the point of the torch to the metal will obstruct the flow of gas and may

*The freedom of a flame from being carbonizing and oxidizing is not necessarily indicated by the clear outline of the cone, which merely indicates that all the particles of oxygen and carbon that come together are burned, but free particles of each may, with some torches, pass through the flame into the molten metal, which is thus injured and gas wasted, even though the theoretically correct proportions of the two gases are being supplied; this condition is only prevented by the extreme mixing vortex which is produced in this type of mixing device, scientifically adjusted for each size of tip.

Such a perfect mixture can never be obtained by such devices as injectors, conical expansion chambers, mixing chambers in head or handle, or any of the numerous devices which have been tried. You will realise that this is so if you try and think of a device that will produce a greater vortex, or mixing of the two gases, than by driving them together, both under considerable pressure, at uniform velocities obtained by a different mixing passage with each size of tip, and with the gases correctly proportioned for such passages and pressures.

cause it to back-fire and burn within the tip. In such case, turn off the oxygen immediately and the torch will then relight, the correct flame being again obtained as described at 12.

The table published will give the oxygen pressures best adapted for the size of tip in use. It should be carefully studied, and frequently referred to, until the operator becomes familiar with it. This will be helped by noting the relation of the pressures to the tip numbers.

Both the oxygen and the acetylene gases should always be turned off at the service pipe, or acetylene cylinder, and at the oxygen cylinder, when welding is discontinued.

## Learning to Weld

Beginners should commence by welding thin strips of iron or steel ⅛" or less in thickness. These light metals can be welded without the addition of welding material. The torch should be given a slow cross motion, with a slight forward movement. This will tend to blend the metal, and reduce the liability of overheating. The practice on this light metal should be continued for a day or two, or until the operator becomes instinctively familiar with the apparatus, so that he can devote his whole attention to the flow of the metal. It should be realized that muscular training is necessary in this way, until complete control of the torch is obtained.

There is a strong tendency with beginners to experiment with various kinds and thicknesses of metal, but they will become efficient far more quickly by mastering one kind of weld before undertaking another.

## Back-Firing

Flash-backs, or back-firing in the torch, are of more or less frequent occurrence, dependent on the type of torch used and upon local conditions. With some types of welding torch this condition is due to the design of the torch itself and the principles under which it operates, presenting a serious hazard in their operation. The basic principles and design of the Davis-Bournonville torch, as a result of long experience and knowledge of the use of acetylene and oxygen for welding and cutting, are such that back-firing, or burning of the gas back in the torch tip, seldom occurs except as it is due to local conditions and usually careless operation. The cause of back-firing is due to insufficient flow of gas from the outlet of the tip. If the flow is sufficient, the gas will burn outside the tip. If the pressure of acetylene is insufficient, if the hole in the tip is obstructed *by dirt, particles of* molten metal, letting the tip rest against the work or

drop into the molten metal while welding, or if the tip is excessively overheated, the flame will pass back into the tip. In nearly all cases it is due only to the operator not having sufficient acetylene pressure turned on at the regulator. The remedy is obvious—use the proper pressures recommended by the manufacturer, because each size of tip is drilled for an accurately determined flow of both gases at specified pressures. When a back-fire occurs in the tip, immediately turn off the oxygen with the torch needle valve (the upper valve) and the gas will relight outside the tip; if not, turn off the acetylene at the regulator, examine the tip, clean if necessary, turn on the proper acetylene pressure, and relight.

### Points to be Observed

See that the pressure of the acetylene generator is properly adjusted; it should not exceed 12 pounds maximum. The feeding motor should operate at about 10 or 11 pounds. Follow the Rules and Regulations of the National Board of Fire Underwriters and the instructions attached to the generator, for location, setting up, and operation.

The operator should examine the "flash-back" cylinder on the pressure generator every week, to see that the water is at the proper height, as shown by the instructions which accompany the generator.

Do not make any change in any of the safety devices on the generator, or prevent them from functioning in any way. They are all put there for a reason, and even if you do not know why, don't take a chance.

Be careful that there are no leaks in any of the connections, or in the rubber tubing, and that the torch tip is always free from obstruction.

Always have an ample supply of gases before commencing a job, as it is injurious to stop in the middle of the work.

Always wear tinted glasses, or goggles.

If the flame is accidentally extinguished, the oxygen should be turned off, and the acetylene jet turned away from the heated surface of the metal, or cut off, so that the metal will not be injured.

In doing heavy work, if the torch is used continuously for a long time, or held in a confined space, it will become heated. In such case, turn off the gases and dip *only the torch tip* half its length in cold water.

When working inside a boiler, or tank, or any small enclosure, two operators should be employed, so that one will be available to quickly turn off the gases in case of accident, such as the bursting of the hose.

In very heavy welding, two operators should always be used, so that one can relieve the other, and the work be continued without interruption until finished. In a great many cases it is disastrous to leave the work even for a few minutes before it is completed.

An excessive discharge of sparks indicates that too much oxygen is being used, and that the metal is being burned, or oxidized. In very heavy welding there will, of course, be a considerable volume of sparks, even when the flame is correctly adjusted.

Care should be taken to remove the scale and clean the surface wherever the metal is to be welded.

Butt welds made with the edges beveled, so as to form a groove of 90 degrees, should be used wherever possible. No welds over ⅛" thick in steel and ¼" in cast iron should be made without beveling.

No one but a thoroughly instructed, experienced operator should attempt boiler welding, and then only with the consent of the constituted authorities.

In cleaning the torch-tips, do not use steel; employ copper wire or some other soft metal.

Remember that the welder who does not insist that the thicker metals to be welded be beveled, or chamfered, to their full depth, that all metal from previous welds be removed before rewelding, and who does not cause the edges of the metals to be thoroughly molten at all times before adding the welding metal, and does not make it a practice of touching the adding metal to the parts to be welded, will always be an inferior operator.

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## Preheating

### Expansion and Contraction

As practically all metals expand upon heating and contract upon cooling, the heating of any piece of metal locally must act as a wedge and tend to tear the metal apart. Thus in brittle metals, local welding may cause fractures either during heating or cooling, whereas ductile metals, providing their ductility is not exceeded, will adjust themselves, either by stretch or warping, to this condition.

It is, therefore, necessary to apply heat over an extended area when welding cast iron, and other brittle metals, under conditions where the metal cannot spring apart. This, in small articles, may be done with the welding flame, but in large castings is usually accomplished by means of a charcoal or coke fire, or gas or oil torches.

It is frequently difficult to determine where a casting should be preheated, and it will help those having the matter in hand if they will imagine where the part would break if a wedge was driven in at the point to be welded, this being the place to preheat.

Preheating is also of value to reduce the time and gas consumption

on all heavy jobs even though not required to relieve strains. It is also necessary on all heavy steel pieces, as otherwise satisfactory welds cannot be made, for the metal welded will cool too rapidly.

When the metal has been preheated, sheets of asbestos paper can be placed over it to protect the operator, and prevent heat radiation, of course leaving the portions to be welded exposed to the welding flame.

When the weld is completed, the torch flame should be passed over the weld, and the portion adjacent thereto, until the surrounding metal becomes the same color as the part where the last weld was made; or, better still, additional fuel can be piled on until this uniform condition is obtained. The whole metal should then be covered with asbestos, and allowed to cool slowly, drafts of cold air being most carefully avoided. The preheating flame should never be directed against the weld itself, but the heat should be evenly distributed, if possible, so that the article to be welded will be heated uniformly throughout.

All welds of brittle metal should be tested by judicious jarring with a hammer, so that if excessive internal strains are present they will relieve themselves at that time by cracking, instead of the fracture occurring when the part is again in operation.

## Expand Before Welding

It cannot be too strongly impressed upon the operator that it is far better to produce expansion by heat before welding, rather than attempt to care for the contraction afterward.

Where there is a straight crack, even in steel, it can usually be opened uniformly by heating the metal at each end, and keeping it hot while the weld is being made, when it will be found that the strains set up by the contraction caused by cooling have been greatly minimized.

Where a piece of metal has been broken squarely in two, or a projection has been broken off, preheating will not be necessary, unless in heavy welds it is desired to reduce the time of operation, and save the consumption of gases.

Never add metal from the welding stick, or wire, before the part to be welded is itself in fusion, and always have the welding stick in contact with the work when adding metal, to prevent the drop of added metal being overheated by the 6300 degree flame; at the same time the adding metal should be rubbed into the weld whenever possible.

In heavy welding, the parts to be joined must be brought to a red heat for a distance of, say, three times its thickness on each side of the weld, up to 1 inch in thickness, increasing the distance reasonably as the weld exceeds this thickness.

### Heat the Surrounding Parts Sufficiently

In heavy welding, it frequently occurs that the direct application of the flame to the spot to be welded does not cause fusion. The cause is that the metal surrounding this spot is not hot enough, the heat being conducted into the cold metal. The remedy is to play the flame around the refractory spot until the surrounding metal is at a white heat, then apply the flame to the spot itself, and it will quickly fuse.

In welding two pieces of metal together, care must be taken not to heat one side more than the other, for if this is done the hottest piece will expand most, throwing the work out of alignment, possibly causing the weld to crack in cooling, because of uneven contraction. It may also cause adhesion or insufficient fusion on the cool side.

### Proper Size of Flame

Do not use too small a tip for the thickness of metal to be welded, because in such case the heat will be radiated almost as fast as produced, and the flame will have to be held at one point so long before the weld can be accomplished, that the metal will be burned. Furthermore, it will take much longer to make the weld and require a much greater consumption of gases to do the work.

Too large a flame is equally bad, because the operator will not be able to correctly place the mass of molten metal fused. The proper flame will reduce the metal to a molten condition, and of a width about equal to the thickness of the metal welded.

When welding heavy metal, be very careful not to blow a part of the molten metal on to a portion of the weld that is not in fusion (called an "adhesion"), as it will make a defective weld at that point. If this should occur, do not fail to pass the flame over this chilled portion until it is again in fusion with the molten metal of the weld.

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### Cast Iron

If the piece to be welded is of such form that it will be liable to crack in cooling, it should be preheated, but not sufficiently to warp the metal, no part to be brought to a dark red except at the welding point. Charcoal is a good material to preheat with, as the heat is uniform and not excessive. A blacksmith's forge, in connection with a sheet-iron hood, can be used to good advantage. Another method of preheating is to build up around the piece with firebrick in such a manner as to cause the heat to be confined and distributed evenly, with an opening left through which an oil or gas flame can be used. A heating oven is also convenient for this

purpose. Whether the metal is preheated or not, it should always be covered immediately after the weld is finished, and allowed to cool slowly. Some operators use slaked lime or very dry sand in which to bury the parts until they cool. Where the conditions will permit, it is best to allow parts to cool in the position in which they were preheated. The shredded portion of waste asbestos paper, collected in a metal box, can be used to bury the small parts in.

If the metal is more than ¼ inch in thickness, the edges should be chipped or ground to a beveled form of 45 degrees on each side. In welding irregular shapes it is desirable to leave three slight points of contact to assist in adjusting and holding the broken parts in their exact original position.

To start the weld, the flame should be passed for some distance around the fracture, gradually reducing the circle until it is concentrated at the point where fusion is required, and then directed on to the fracture until the metal becomes a cherry red. When this occurs, have an assistant throw on a little scaling powder, and when the metal begins to run, add cast iron from the welding stick. Powder should only be added when the metal does not flow well; but do not add too much, and finish with as little powder as possible, as an excess will tend to make the weld hard. Beginners will generally find that their cast-iron welds are hard. This will disappear when they become expert in the handling of the flame.

Much ingenuity can be used in overcoming the bad results of expansion and contraction, and in making repairs that might at first have appeared impossible. For instance, in welding the combustion chamber of an automobile cylinder, a piece can be cut from the outer shell of the water jacket, the crack repaired, and the piece which was removed welded into place again.

Never attempt to weld pieces that have been previously brazed, without cutting away all the brazed metal.

Carbon blocks are extremely useful for confining the metal when building up.

## Steel

Steel of ⅛ inch and less in thickness may be welded without the addition of any welding metal. Thicker metal should be beveled or chamfered and will always require metal to be added.

In welding steel, remember that the welding material should never be added until the edges of the metal to be welded are fused, or molten, at the place where the weld is being made.

In no case should the flame be held on to the weld until a foam is

produced, as such foam is an indication that the metal is being burned.

When adding metal to the weld, always hold the added metal so that it touches the metal to be welded. This enables the heat to be radiated from the welding rods to the body of the metal to be welded, whereas if the welding metal is allowed to drop through the flame, it probably would be burned to an injurious extent. Do not hold the flame steadily in the center of the weld, but use a slow cross motion with a steady forward movement, always driving the molten metal toward the center of the weld.

In welding a crack in the middle of a heavy steel sheet, prepare the crack by chamfering the metal on each side at an angle of 45 degrees right through to the bottom; then, as previously directed, apply the welding torch to the metal beyond the end of the crack until it is expanded enough to open the crack perceptibly and proceed to make the weld while the metal is in this condition. Usually it will be found that expansion then given has been sufficient to offset the contraction in the weld when cooling.

## Aluminum

Aluminum to be welded should be well scraped and cleaned, on account of oxidation, and all aluminum solder, or paint, which may have been previously used must be removed. If the metal is more than ¼ inch in thickness, it is advisable to chamfer it.

The oxy-acetylene flame may be softened by using an excess of acetylene to an extent which will be indicated by the extension of the acetylene cone from 1 inch to 1½ inches beyond the white cone. This excess of acetylene does not injure aluminum, but lowers the temperature of the flame, which is desirable in welding aluminum.

To make a good weld in aluminum, it may be necessary to heat the whole piece to be welded by a charcoal fire, or in a furnace, to about 600 degrees F. A good deal of the work may, however, be accomplished by a skilled welder without preheating, particularly if the metal is alloyed with copper and not zinc. Cover the piece with asbestos, or by other means, making an opening where the weld is to be made, thus keeping the whole piece hot until the weld is completed. After the weld is finished, cover the piece completely to protect it against drafts, and so that it will cool very slowly to prevent shrinkage cracks.

It will be noticed when the aluminum at the fracture is fused it does not run together; an iron rod, the point of which is flattened, should be used to puddle the aluminum and this rod should be wiped frequently, so that it will not become coated with aluminum. A good aluminum flux will be found advantageous. Great care should be taken not to let

the rod reach a red heat, as this would cause oxide of iron to form, and this mixing with molten aluminum would make a defective weld.

In some cases temporary molds of plaster of paris or fire clay can be used to advantage in making welds. There are many pieces of aluminum that can be welded together without preheating, as will soon be learned by the experience of the operator. Lugs or projecting pieces broken completely off do not require to be preheated. Pieces broken out or pieces entirely lost can, in nearly all cases, be fitted in O. K. or built up with little difficulty.

### Brass and Bronze

Adjust the flame with the single cone as for steel welding. Keep the point of the white flame slightly away from the weld, according to the thickness of the piece, so that the heat will not be sufficient to volatilize the zinc or tin which is in the brass. If a white smoke should be created, remove the flame, as this indicates that too much heat is being used. A good flux should be used in both brass and bronze welding. In welding these metals it is desirable to use about one size larger tip than for an equal thickness of steel.

Care should be taken not to breathe any fumes given off while welding brass.

### Copper

To weld copper, use the same kind of flame as for steel, but a much larger tip and flame must be employed for pieces of equal dimensions, because of the great radiating property of copper. Preheating is necessary when a large piece of copper is to be welded; otherwise the heat of the torch would be absorbed by radiation, and little left for the fusion of the metal.

Welded copper has only the strength of cast copper, but it can be rendered more tenacious by hammering.

The radiation of heat from copper can be much lessened by covering the same with asbestos sheets while welding.

### Copper to Steel

To weld copper to steel, first bring the steel to a white heat (the welding point), then put the copper into contact and the two metals will fuse together, making a perfect weld. When the copper commences to flow, withdraw the flame slightly, in order not to burn the copper.

### High-Speed Steel

To weld high-speed steel to ordinary machine steel, the end of the high-speed steel to be welded must first be heavily coated with soft special iron. This can best be done by preheating the piece uniformly all over

as hot as is safe before welding. After being cooled, it can then be welded to an ordinary machine steel without burning; but it takes an experienced welder to make a good weld of this kind.

### Cast Iron to Steel

To weld cast iron to steel, cast-iron rods must be used as the welding material. The steel must be heated to the melting point first, as cast iron melts at a lower temperature. Very little scaling powder should be used.

### Malleable Iron

Welding malleable iron is difficult for several reasons. If brought to the melting point, and kept there for any length of time, the metal becomes spongy. When brought to the melting point it is no longer malleable iron, but is practically cast iron. It is, therefore, undesirable to fuse it. This can be obviated by using a bronze welding rod with a good flux in much the same way as brass is welded. If properly done this will have a strength comparable with the malleable iron.

### Oxygen Cutting

Steel, wrought iron—or, as it is sometimes called, "old fashioned iron"—and cast steel are the only materials capable of being cut by this process. *Cast iron cannot be cut.*

The work requires a cutting torch and cannot be done successfully with the welding torch.

The process consists of heating a spot of the metal to be cut to a red heat and projecting upon it a jet of pure oxygen which causes the metal to burn away, a stream of oxide running out of the kerf thus produced.

The torch is advanced at a rate dependent upon the thickness and nature of the metal and the pressure and volume of oxygen being used.

The cutting equipment is set up in the same manner as the welding equipment, except that the oxygen regulator is set at the pressure necessary to produce the required cut. This may be taken from the table.

After lighting the acetylene, the oxygen is turned on by means of the by-pass needle valve on the side of the handle, until a correct flame is obtained. It will be necessary to adjust the flame with the cutting trigger valve *open* to get correct results.

Tips for different purposes have from one to five flames; the tip with two heating flames and one cutting jet is used for most classes of work. These are played upon the metal until it is seen to glow all over. The trigger on the underside of the handle is then pulled with the first finger, allowing a stream of oxygen to impinge on the hot spot, which starts

the cut, and when it is desired to stop, the trigger is pushed in the opposite direction by the back of the second finger.

The torch is traversed along at a uniform rate about the same as that necessary to saw by hand equal thicknesses of hard wood. The torch must be kept moving or the flow of slag stops, thus stopping the cut.

The principal factor in successful cutting is to properly support the body and torch to as great an extent as possible commensurate with the forward movement of the torch. The position must be an easy one, as muscles under tension will cause vibrations and these are fatal to good cutting. This is one condition in which "lounging" is allowable, and an actual benefit.

Oxygen pressure should be kept as low as possible, and the most economical cut is one in which the striations formed on the surface of the cut show a considerable lag. This, however, affects somewhat the smoothness of the cut. Extreme smoothness is more dependent upon a uniform correct traverse in accordance with the size of the tip and pressure being used. Too fast and too slow traverse will both produce a rough cut.

When the torch is held in a machine such as the Oxygraph, Radiagraph, Magnetograph or Pyrograph, very smooth, accurate results are produced, comparable with roughing machine tools.

The Radiagraph is a motor-driven device, with oxy-acetylene or oxy-hydrogen cutting torch, adapted to cutting along straight lines or circles in steel plate from ¼ inch to 18 or 20 inches in thickness, the speeds varying from 18 inches to 2 inches per minute according to the thickness of the plate. For straight line cutting, it operates upon a parallel track, and for circle cutting, with a rod and adjustable center. The device consists principally of a three-wheeled carriage driven by an electric motor attached to the carriage, which may be connected to the ordinary lighting or power circuit, either D. C. or A. C., 110 or 200 volt circuit. An adjustable arm and torch holder provides for raising or lowering the torch while in operation, and for adjustment at an angle for bevel cutting. The adjustable arm also permits of following an irregular line within a variation of 3 inches on either side of a straight line. The cutting torch is connected by hose to the gas supply. The machine is portable, weighing approximately 50 pounds complete, and has proven an invaluable aid in steel cutting, greatly facilitating such work in shipyards and steel mills, several machines being employed advantageously in some of the larger plants. See Plates LXVI and LXVII.

Numerous special tips are available for special purposes, including bent tips to trim off flanges close to the web of structural shapes and to cut off rivet and bolt heads, and for cutting inside of boiler tubes.

## TABLE I.—Factors in Machine Cutting

Style "C" Machine Torch

| Cutting Tip No. | Thickness of Steel | Pressure of Cutting Oxygen | Pressure of Heating Oxygen | Cubic Feet Oxygen per Foot of Cut | Cubic Feet Acetylene per Foot of Cut | Inches Cut per Minute |
|---|---|---|---|---|---|---|
| 2 | ¼" | 15 lbs. | 4 lbs. | .67 | .078 | 18" |
| 2 | ½" | 30 " | 4 " | 1.20 | .088 | 16" |
| 2 | ¾" | 40 " | 4 " | 1.60 | .094 | 15" |
| 2 | 1" | 45 " | 4 " | 2.64 | .140 | 10" |
| 2 | 1½" | 50 " | 4 " | 3.63 | .175 | 8" |
| 3 | 1" | 35 " | 5 " | 2.30 | .245 | 10" |
| 3 | 1½" | 40 " | 5 " | 2.89 | .272 | 9" |
| 3 | 2" | 50 " | 5 " | 4.25 | .305 | 8" |
| 3 | 3" | 60 " | 5 " | 6.67 | .408 | 6" |
| 4 | 3" | 50 " | 5 " | 6.00 | .559 | 8" |
| 4 | 4" | 60 " | 5 " | 8.62 | .688 | 6½" |
| 4 | 5" | 75 " | 5 " | 11.34 | .746 | 6" |
| 4 | 6" | 90 " | 6 " | 16.00 | .895 | 5" |
| 4 | 7" | 100 " | 6 " | 17.60 | .895 | 5" |
| 4 | 8" | 110 " | 6 " | 24.00 | 1.119 | 4" |
| 4 | 9" | 120 " | 6 " | 26.00 | 1.119 | 4" |

## TABLE II.—Approximate Consumption of Gases in Machine Cutting

| Tip No. | Thickness of Cut | Cubic Feet of Oxygen Per Hour at Various Pressures | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Acetylene Pressure Lbs. | Heating Jets | | Cubic Feet Oxygen Per Hour | | | | | | | | | | | |
| | | | Acetylene Cubic Feet | Oxygen Cubic Feet | At 15 lbs. | At 20 lbs. | At 25 lbs. | At 30 lbs. | At 35 lbs. | At 40 lbs. | At 45 lbs. | At 50 lbs. | At 60 lbs. | At 80 lbs. | At 100 lbs. | |
| 1 | ⅛" to ½" | 3 | 3.61 | 4.14 | 19 | 23 | 28 | 33 | | | | | | | | |
| 2 | ¼" to 2" | 3 | 7.00 | 8.00 | | 72 | 84 | 96 | 108 | 120 | 132 | 145 | | | | |
| 3 | 1" to 4" | 3 | 12.22 | 14.17 | | 80 | | 100 | | 130 | | 170 | 200 | 260 | | |
| 4 | 3" to 9" | 3 | 22.37 | 25.50 | | | | 160 | | 200 | | 240 | 280 | 360 | 440 | |

## TABLE III.—Approximate Consumption of Gases per Hour in Hand Cutting

| Tip No. | Heating Jets, Cubic Feet Per Hour | | | Cubic Feet of Oxygen Used in Cutting Jets per Hour at Various Pressures | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acetylene Pressure | Cubic Feet Acetylene | Cubic Feet Oxygen | At 5 lbs. | At 10 lbs. | At 15 lbs. | At 20 lbs. | At 30 lbs. | At 40 lbs. | At 50 lbs. | At 60 lbs. | At 70 lbs. | At 80 lbs. | At 90 lbs. | At 100 lbs. |
| 2 | 3 lbs. | 12.22 | 14.17 | 35 | 45 | 55 | 75 | 95 | 115 | 135 | | | | | |
| 3 | 4 " | 19.67 | 22.81 | | | | 80 | 100 | 130 | 170 | 200 | 230 | 260 | | |
| 4 | 5 " | 30.60 | 35.49 | | | | | 160 | 200 | 240 | 280 | 320 | 360 | 400 | 440 |

In ascertaining cost of hand cutting per hour, oxygen may be figured at two cents per cubic foot, acetylene at one cent per cubic foot with acetylene generator, or two cents per cubic foot with compressed acetylene. Conditions will be so variable in hand cutting that an average cost *per lineal foot* of cutting in different thicknesses of steel is difficult of determination. More uniform conditions prevail in machine cutting. In hand cutting it may be assumed that the operator will use approximately one-third more gas and accomplish approximately one-third less cutting per hour than shown by the table of machine cutting, the variation depending on the skill of the operator.

## TABLE IV.—Approximate Hour Gas Consumption for Oxy-Acetylene Welding

### Style "C" Torch

| Tip No. | Thickness of Metal | Acetylene Pressure | Oxygen Pressure | Acetylene Consumption per Hour | Oxygen Consumption per Hour | Lineal Feet Welded per Hour |
|---|---|---|---|---|---|---|
| 1 | 1/32" | 1 lb. | 2 lbs. | 3.21 c.f. | 3.65 c.f. | 30 feet |
| 2 | 1/16" | 2 " | 4 " | 4.84 c.f. | 5.50 c.f. | 25 feet |
| 3 | 3/32" | 3 " | 6 " | 8.14 c.f. | 9.28 c.f. | 20 feet |
| 4 | 1/8" | 4 " | 8 " | 12.50 c.f. | 14.27 c.f. | 15 feet |
| 5 | 3/16" | 5 " | 10 " | 17.81 c.f. | 21.32 c.f. | 9 feet |
| 6 | 1/4" | 6 " | 12 " | 24.97 c.f. | 28.46 c.f. | 6 feet |
| 7 | 5/16" | 6 " | 14 " | 33.24 c.f. | 37.90 c.f. | 5 feet |
| 8 | 3/8" | 6 " | 16 " | 41.99 c.f. | 47.87 c.f. | 4 feet |
| 9 | 1/2" | 6 " | 18 " | 57.85 c.f. | 65.95 c.f. | 3 feet |
| 10 | 5/8" up | 6 " | 20 " | 82.50 c.f. | 94.05 c.f. | 2 feet |

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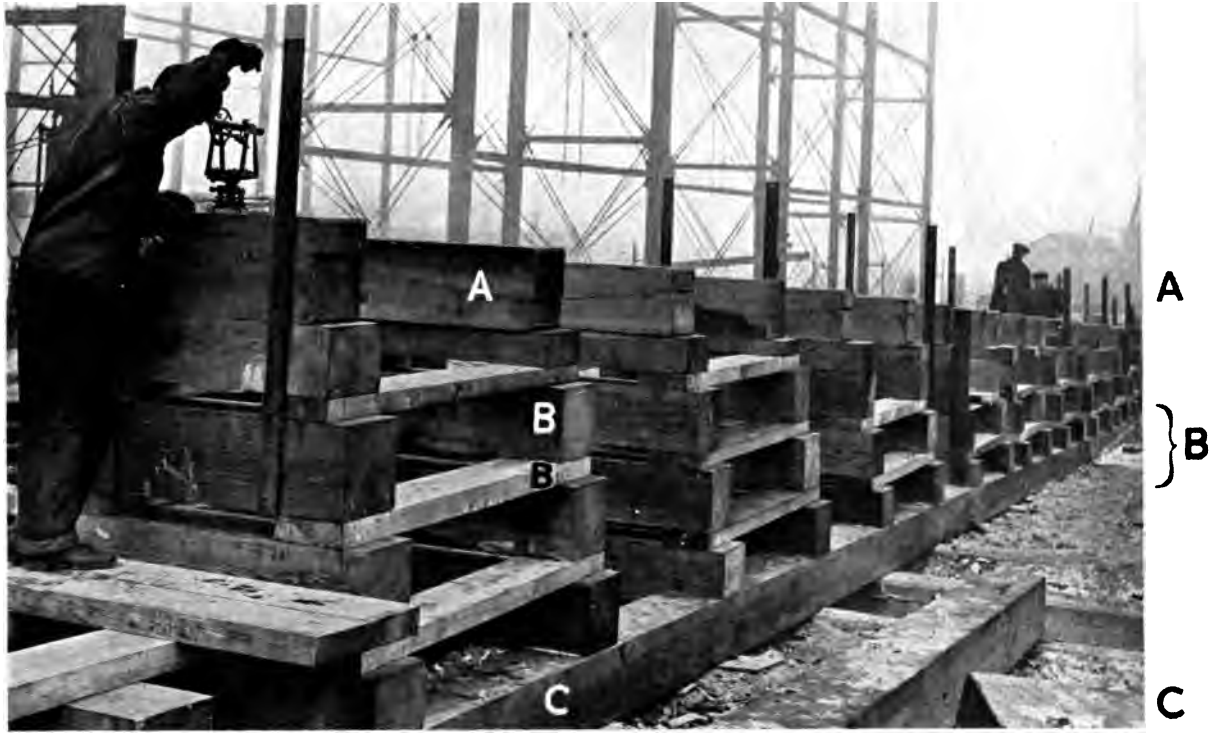



Photo by New York Shipbuilding Co.

PLATE I.—Lining up to set keel blocks. A, wedges to adjust keel blocks which are placed above them; B, cribbing; C, ground blocks or sleepers.

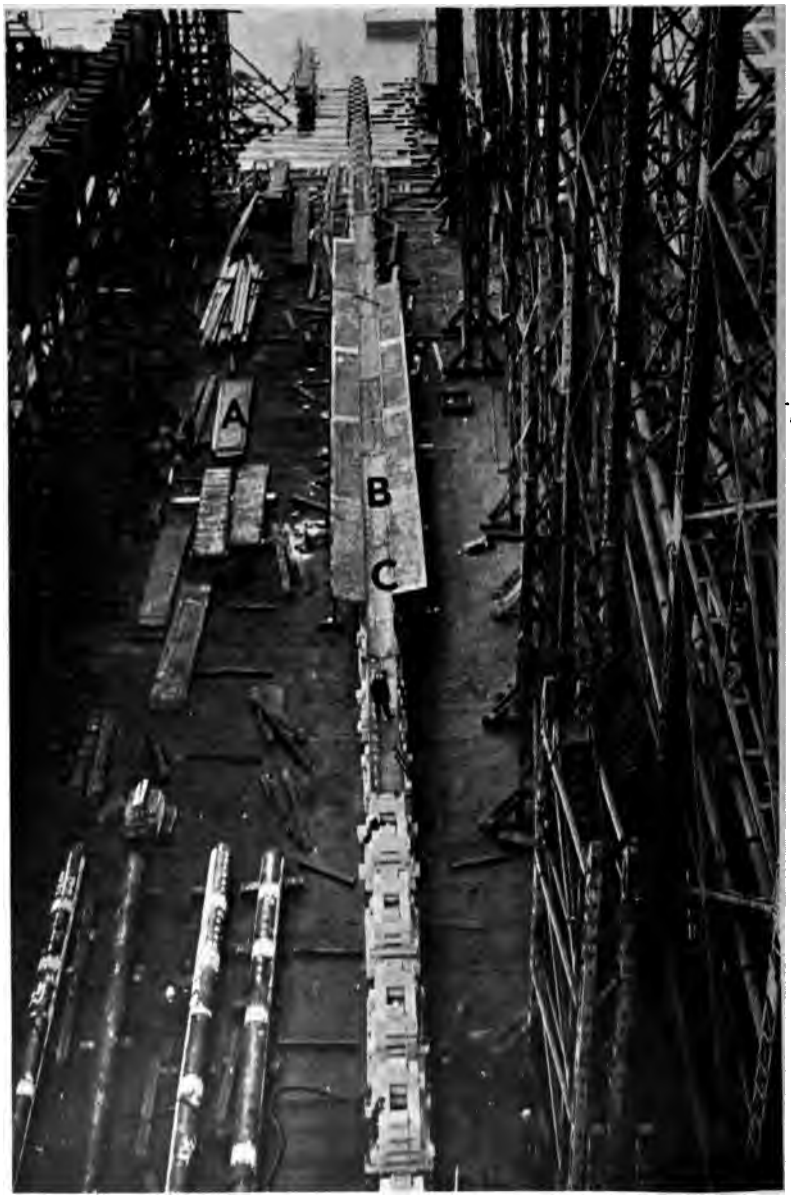
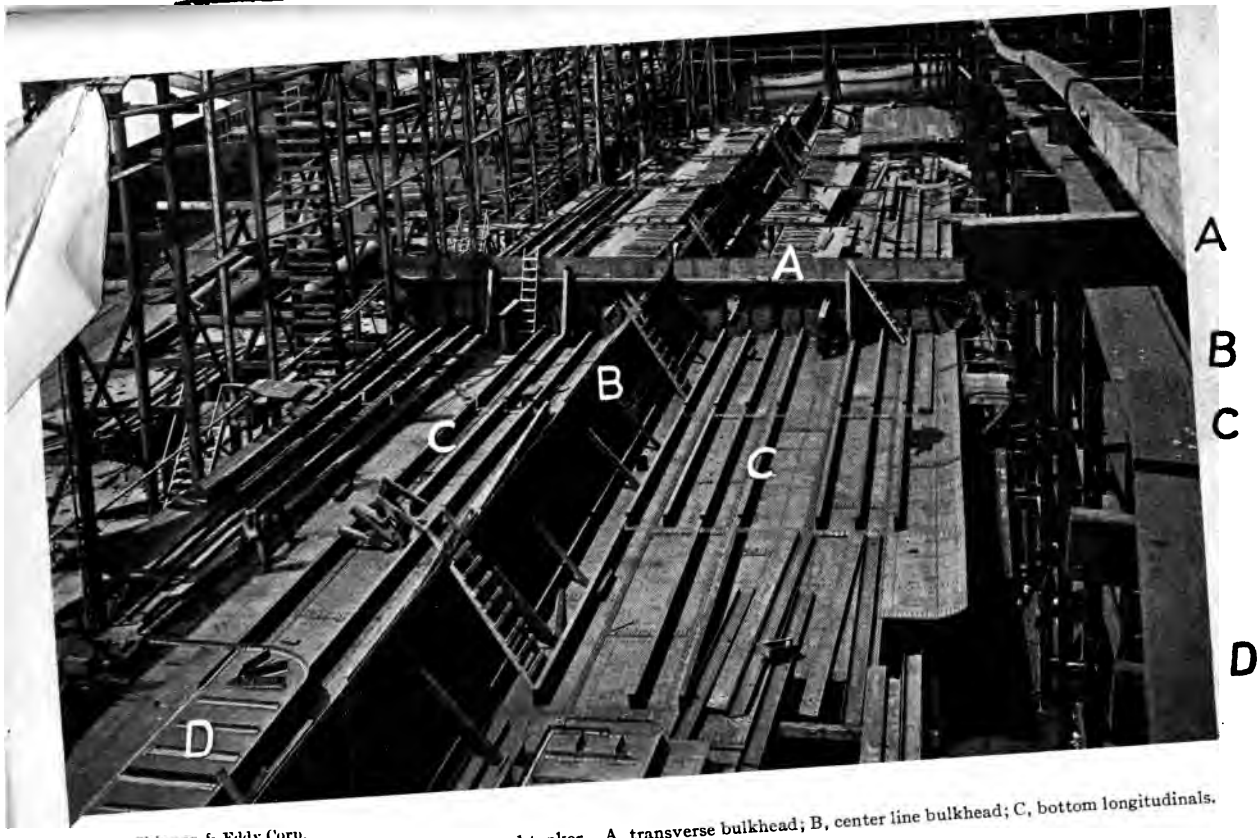



Photo by New York Shipbuilding Co.

PLATE II.—The start, showing some of the flat plate keel in place with a few of the garboard strake plates in place. A, plates ready to place; B, start of laying flat plate keel; C, note that butts of keel and adjoining strakes are staggered.




Courtesy Skinner & Eddy Corp.

PLATE LXIII.—The beginning of an Isherwood tanker. A, transverse bulkhead; B, center line bulkhead; C, bottom longitudinals.

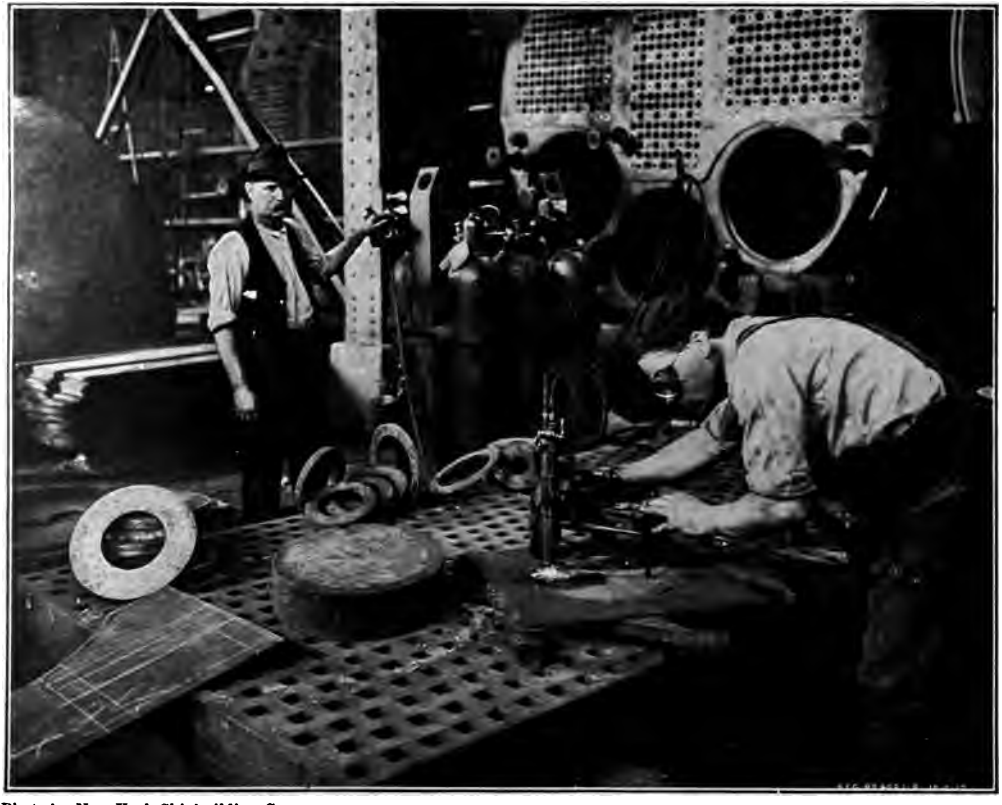
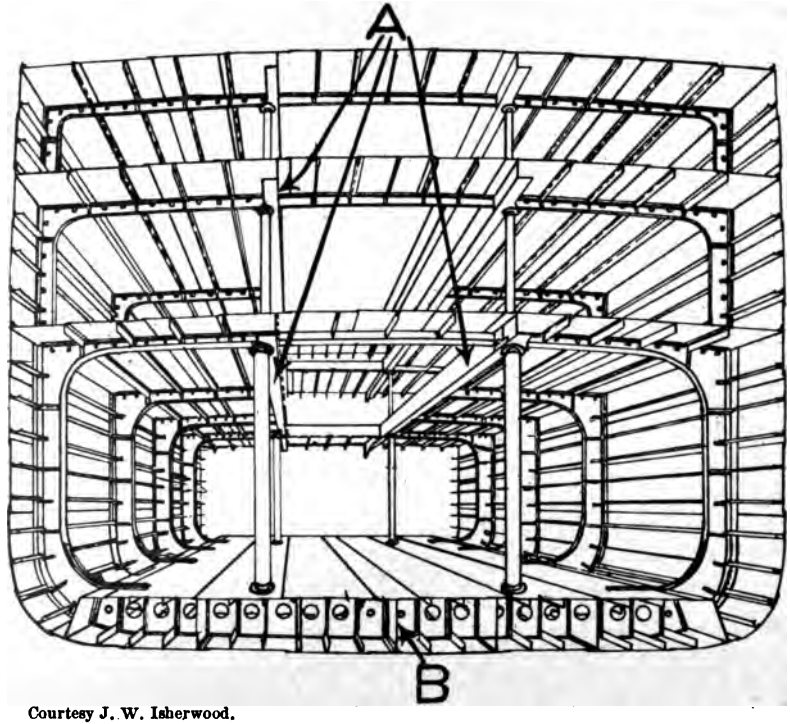


Photo by New York Shipbuilding Corp.

PLATE LXVII.—The Radiagraph used for circular cutting in New York Shipbuilding Yards. Note the true and finished cut and the thickness of the several pieces.

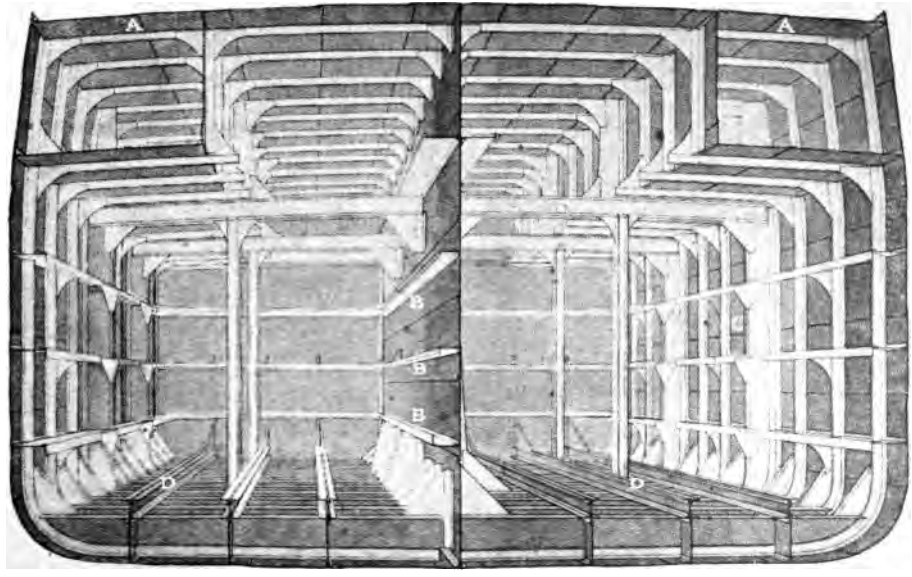
Photo by New York Shipbuilding Corp.

PLATE LXVI.—The Radiagraph cutting steel plate with the oxy-acetylene flame, in New York Shipbuilding Yards, at speeds varying from 18 inches to 2 inches per minute on plate from ¼ inch to 20 inches thick.



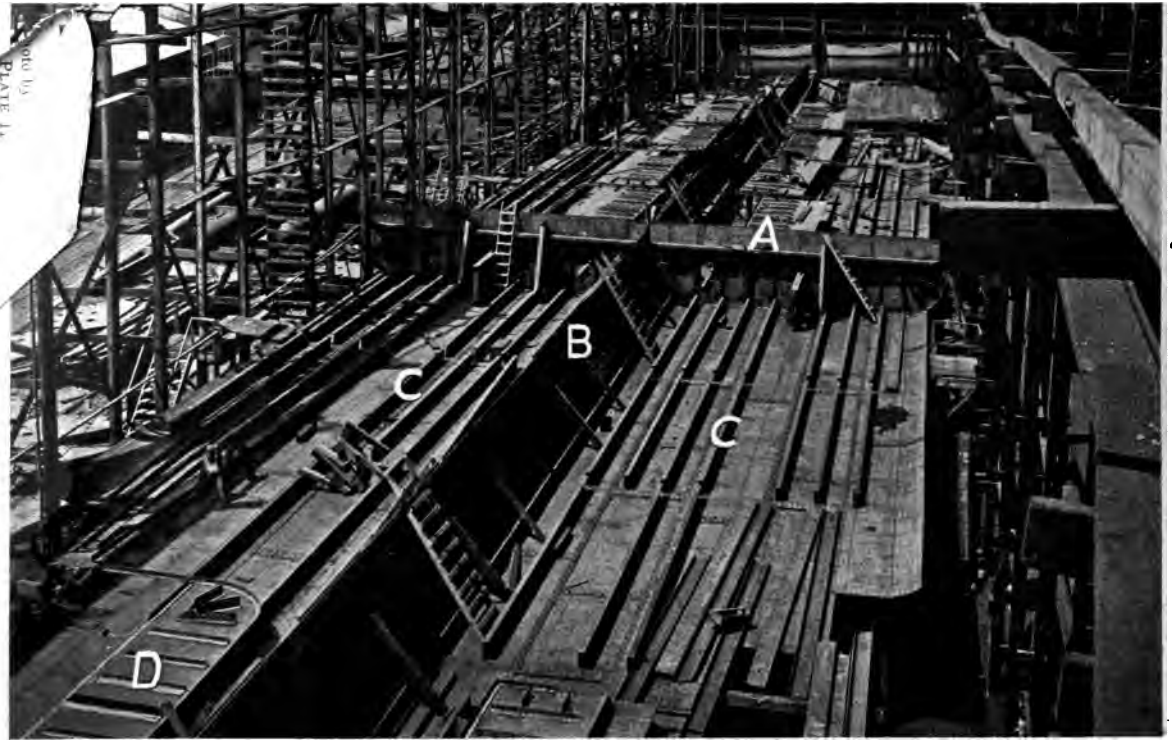

Courtesy J. W. Isherwood.

PLATE LXV.—An Isherwood freighter. A, deck girders; B, center keelson.



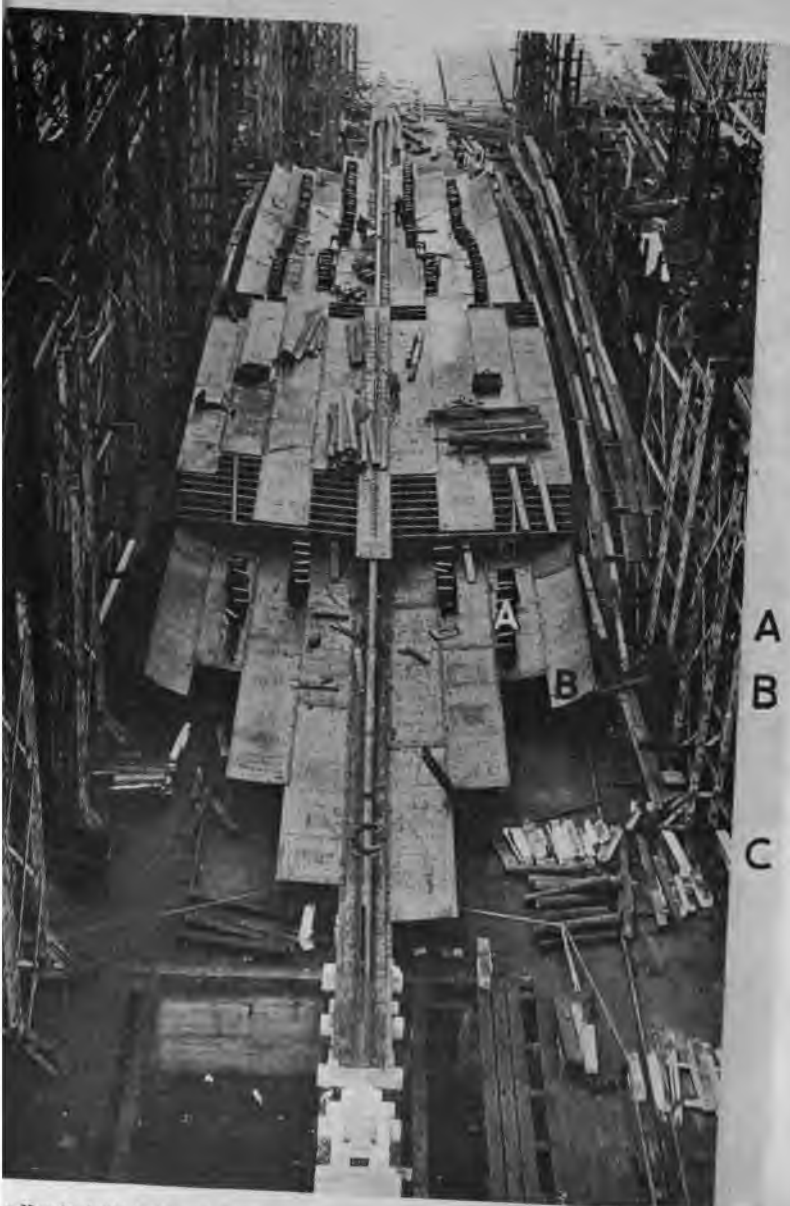

Courtesy of J. W. Isherwood.

PLATE LXIV.—A summer tanker built on the common or transverse system of framing. A, summer tanks; B, longitudinal stiffeners on center line bulkhead; C, web frame; D, side keelsons.




Courtesy Skinner & Eddy Corp.

PLATE LXIII.—The beginning of an Isherwood tanker. A, transverse bulkhead; B, center line bulkhead; C, bottom longitudinals.




y New York Shipbuilding Co.

III.—The beginning of the inner bottom framing and tank top. A, intercostals to be placed parallel to keel; B, lower turn of the bilges; C, center vertical keel.

Photo by New York Shipbuilding Co.

*PLATE IV.—The same ship as Plate III, a few weeks later, showing how the bottom fran shorten and the plating narrows in as they come forward. A, note offset in angle to take ste B, wedges under shores to give frequent adjustment; C, side frames ready to assemble.*

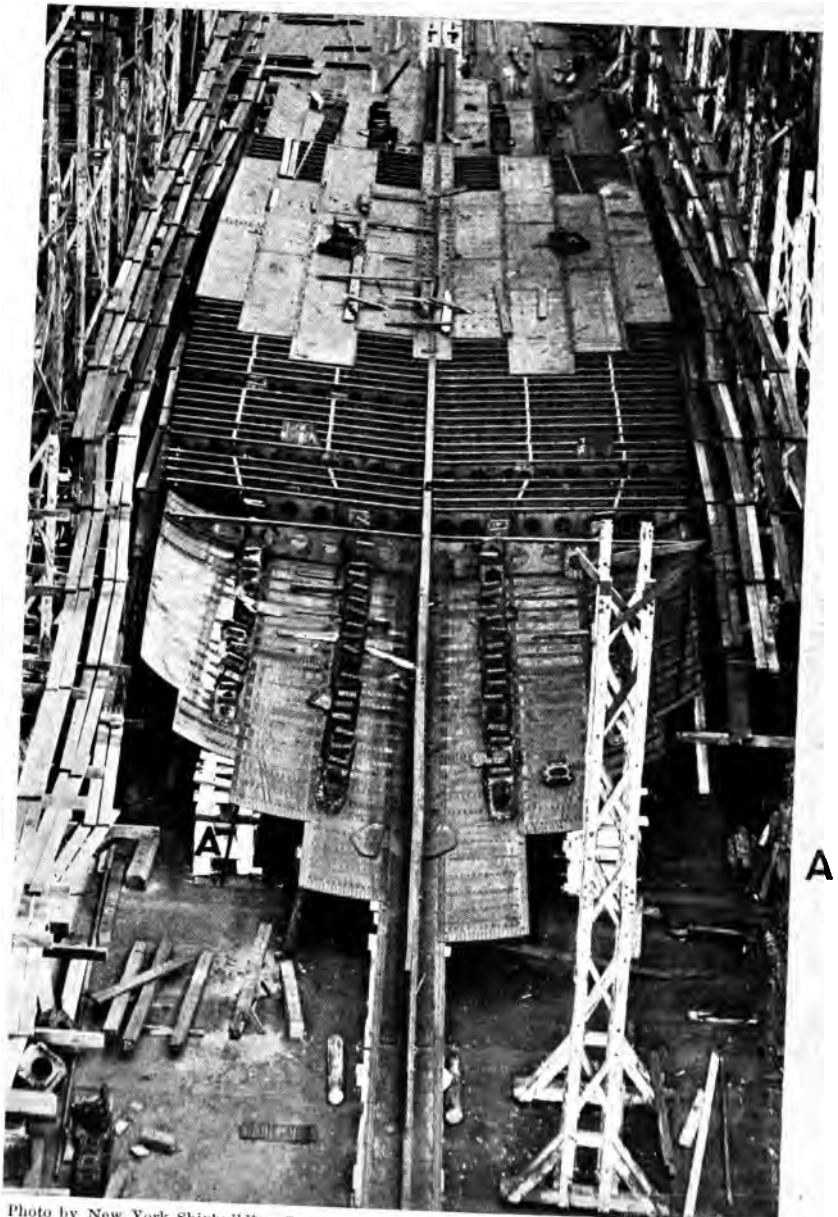



Photo by New York Shipbuilding Co.

PLATE V.—This illustration is used to show the method of giving other support than the keel blocks. A, bilge blocks (later launching ways are built on these blocks).

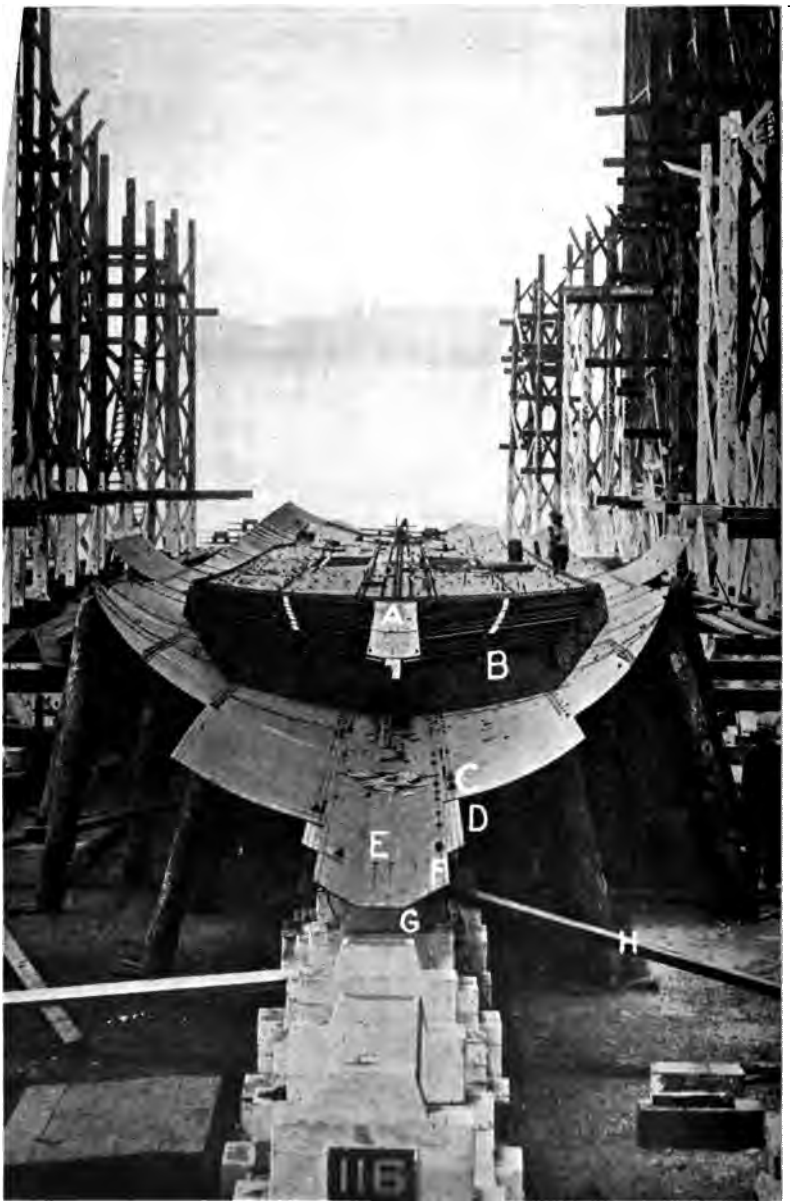



Photo by New York Shipbuilding Co.

*PLATE VI.—Showing one method of building ships extra strong. Double plate keel construction. A, rider plates; B, flanged floor plate; C, note that garboard strake is set on top of outer keel; D, outer keel; E, double keel; F, inner keel; G, keel plate is knuckled or bent up to form; H, shore to hold keel in line.*

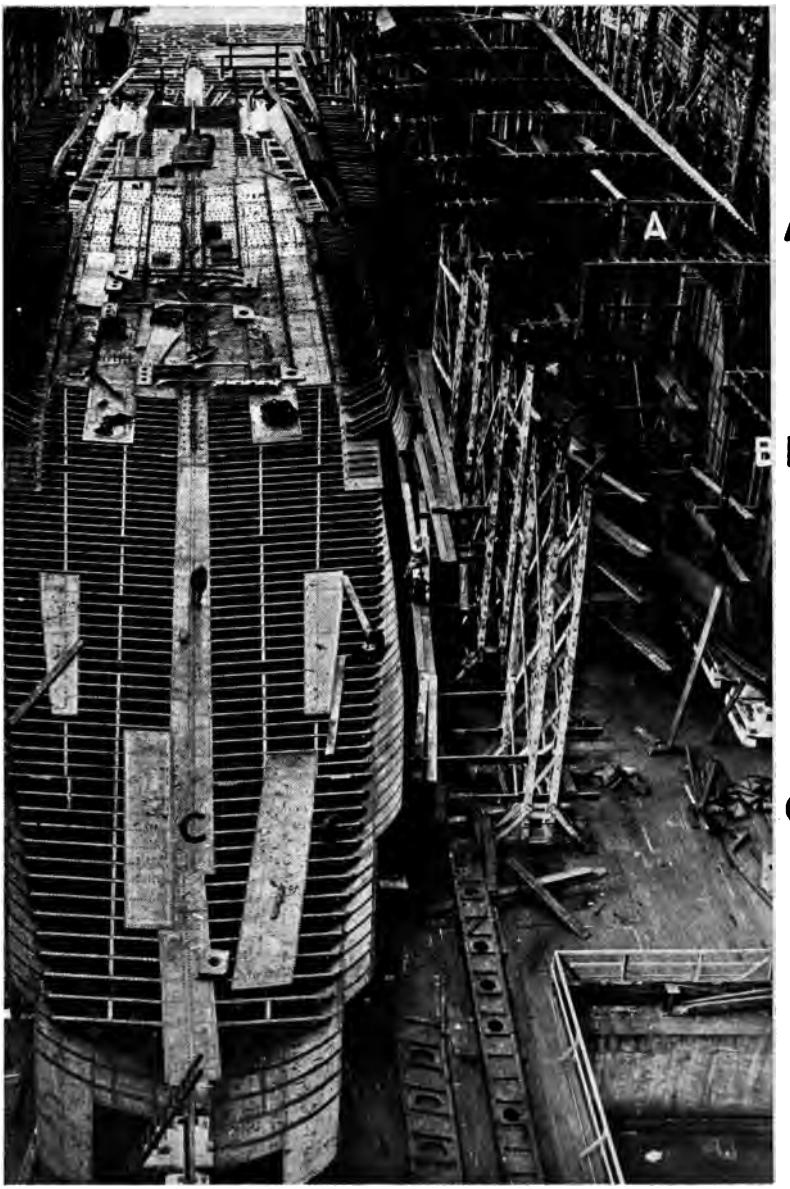



Photo by New York Shipbuilding Co.

PLATE VII.—The ship shown at the right gives a general idea how a tanker is built. A, center line bulkhead; B, bulkhead cut down at fore-peak. Note that stiffeners on these bulkheads have brackets for deck framing; C, center plate of the tank top.

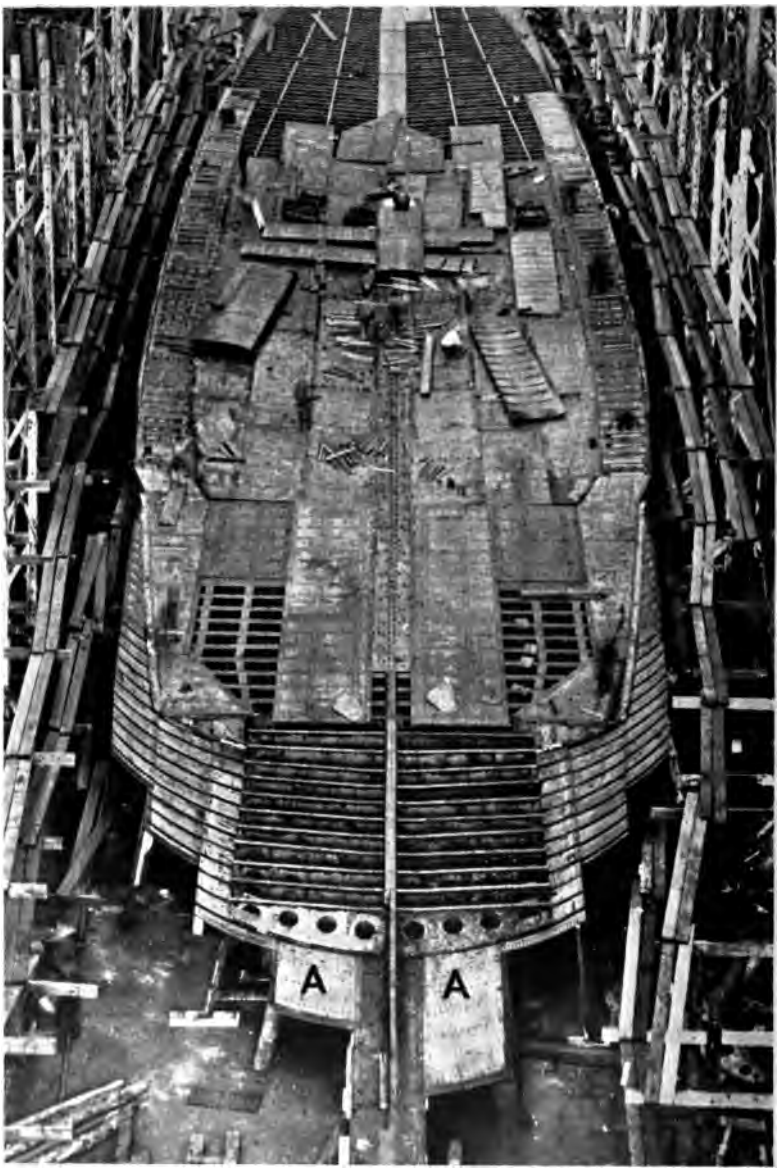



Photo by New York Shipbuilding Co.

PLATE VIII. Same ship as Plates III and IV, looking forward. Shows method of framing *after part* of inner bottom. A, garboard strake of bottom plating.

Photo by New York Shipbuilding Co.

PLATE IX.—Same ship as Plate VIII, showing how side frames are erected. *A*, access holes in tank top (rubber gaskets are used with covers); *B*, clips riveted to margin plate to take frame brackets; *C*, fore-peak bulkhead (beginning).

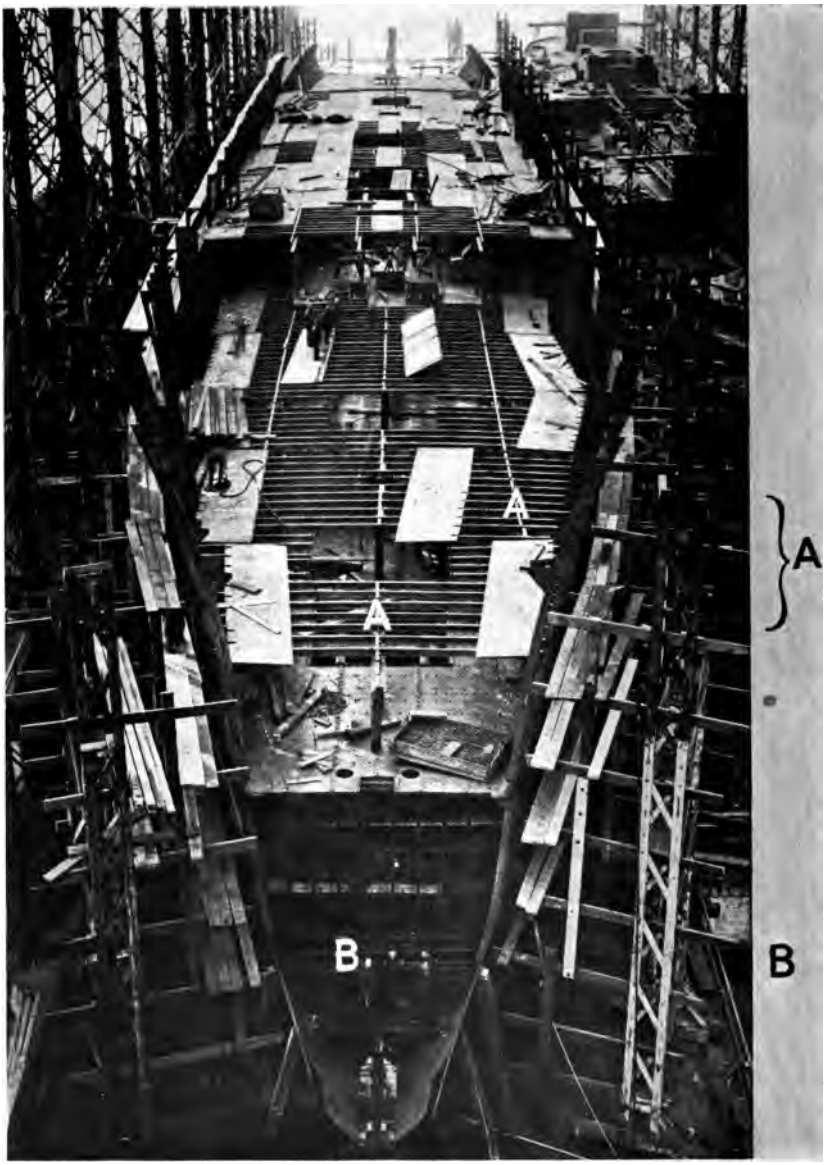



Photo by New York Shipbuilding Co.

PLATE X.—Showing how work is carried on in midships section ahead of that done at *either end.* A, fore and aft line deck girders; B, panting beams.

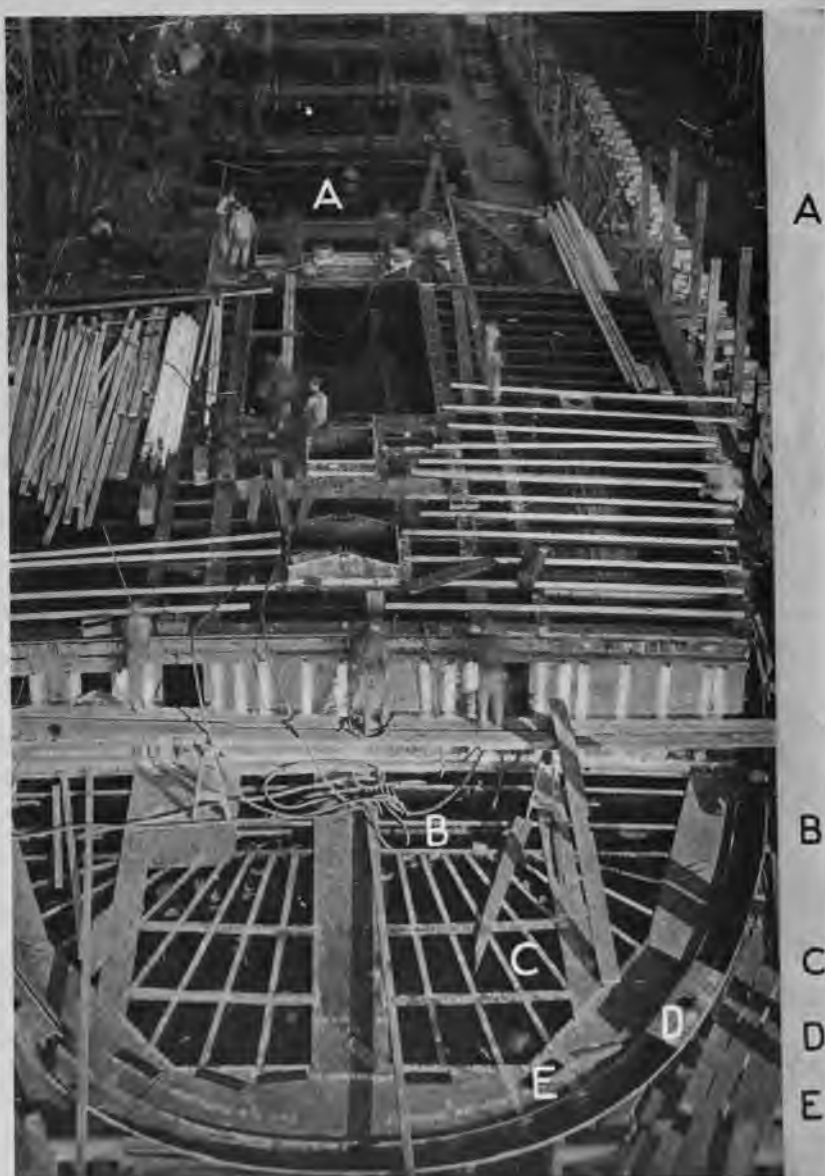



Photo by New York Shipbuilding Co.

PLATE XI.—Showing method of framing at stern. A, cargo hatches; B, transom; C, cant beams (cant frames come directly under and are connected to cant beams and transoms); D, foundation plate for chock; E, waterway angle (deck planking stops here).

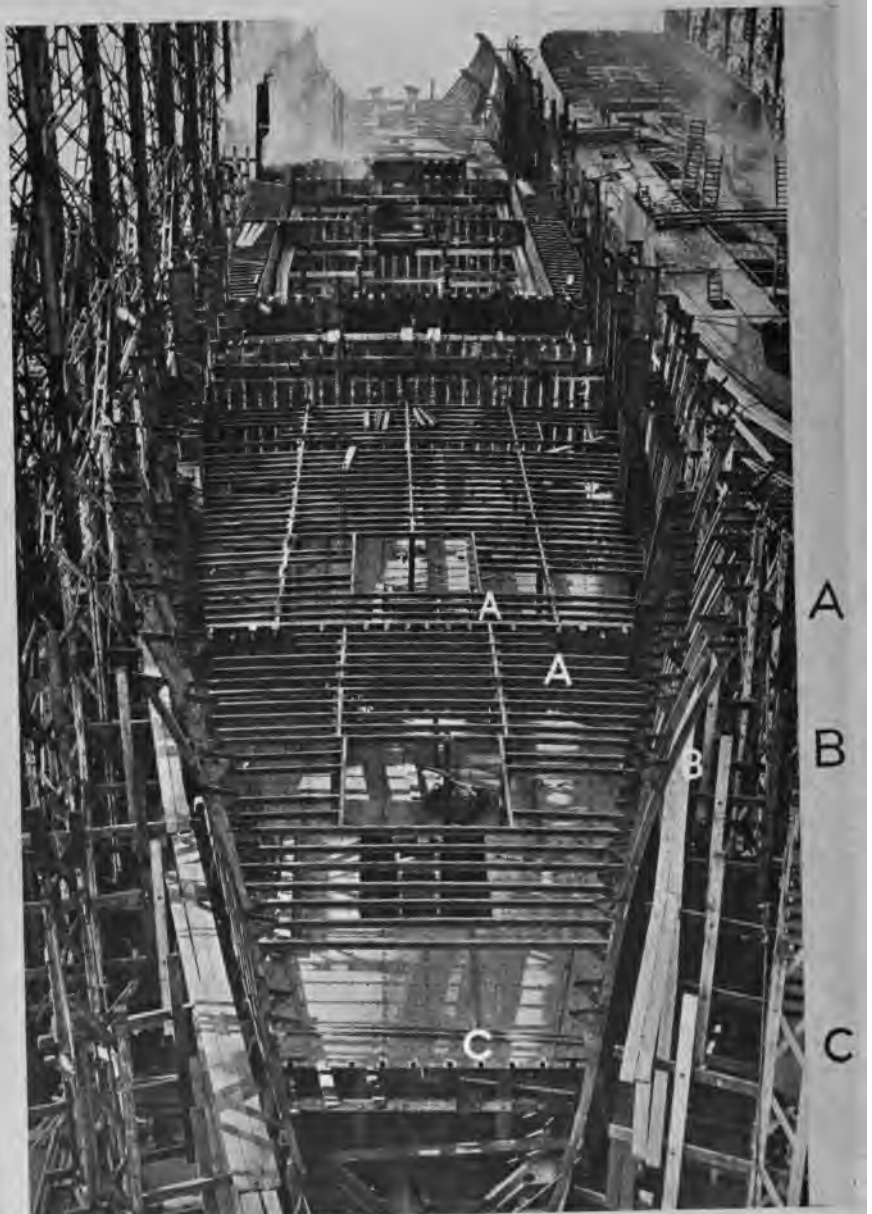



Photo by New York Shipbuilding Co.

*Plate XII.—General view of deck framing. A, deck beams; B, note the flare given to these frames; C, deck plates notched to take stiffeners on fore-peak bulkhead.*

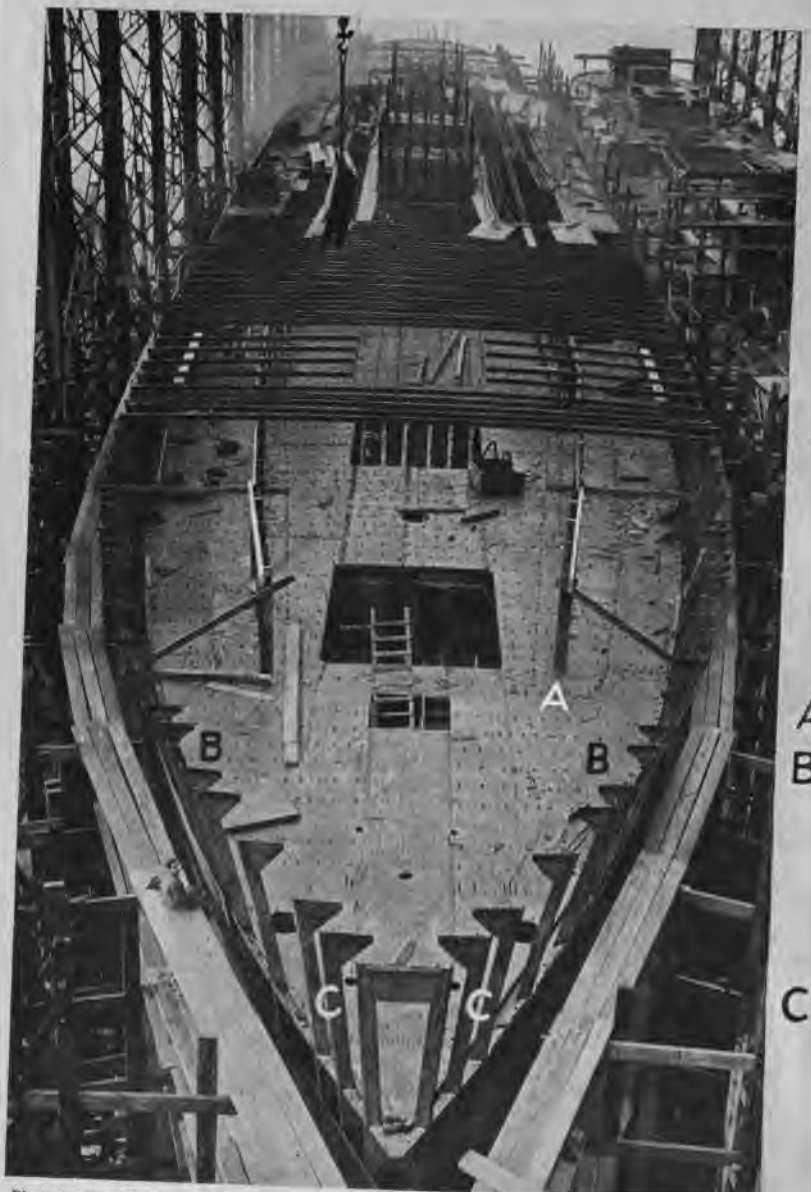



Photo by New York Shipbuilding Co.

PLATE XIII.—Same ship as Plate XII, with bow frames in place and ready to take stem. A, main deck (called strength deck of a vessel); B, stringer plates run entire length and are thicker than deck plates; C, side frames project through this deck.

Photo by New York Shipbuilding Co.

PLATE XIV.—The stem in place and upper deck on. A, part of boiler room casing; B, part of deck house; C, hawse pipe ready to place; D, hatchway; E, hatch coaming; F, manger plate; G, stem.

Photo by New York Shipbuilding Co.

PLATE XV.—View at stern of ship about ready to launch. A, deck carlins; B, roller chock; C, rail and stanchions; D, knuckle; E, horseshoe plate; F, rudder stock; G, lug for tackle to remove propeller; H, rudder flange; I, cargo port; J, rudder clamp, temporary while launching; K, propeller strut; L, draft marks; M, rudder; N, stern tube; O, ground ways.

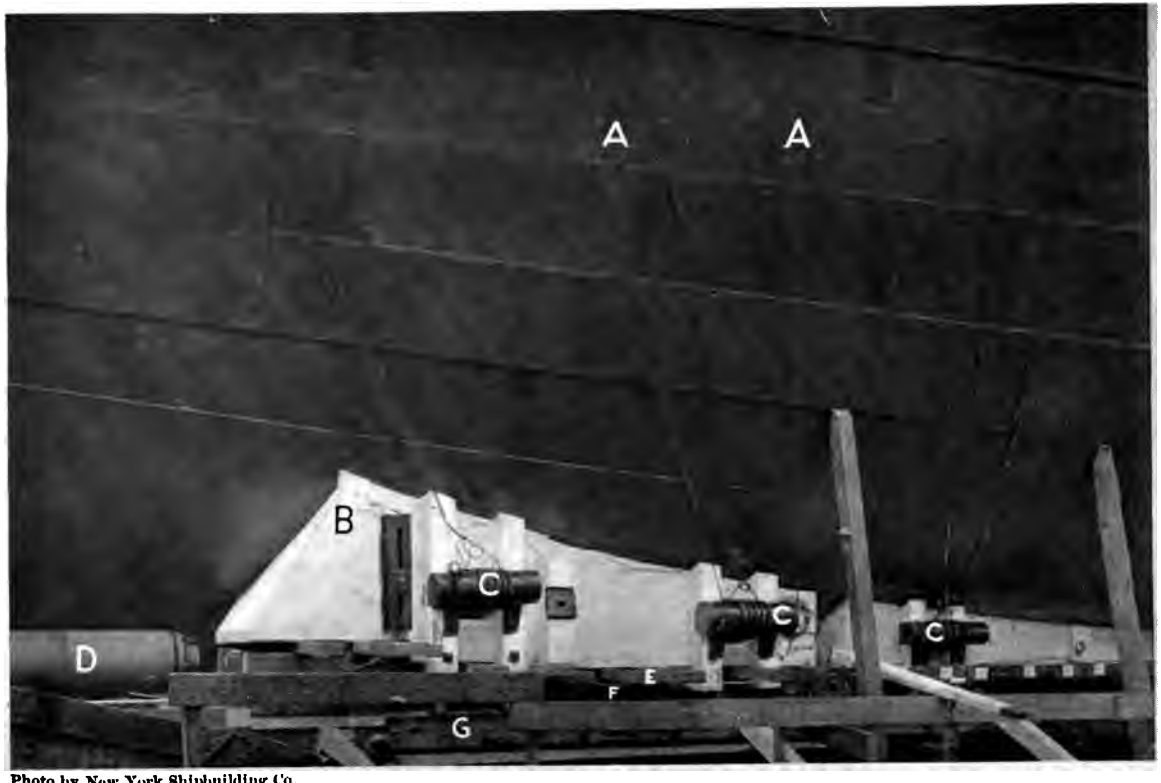



Photo by New York Shipbuilding Co.

PLATE XVI.—Showing method of securing forward end of cradle. A, lines to deck to recover gear; B, launching cradle; C, cylinder to take lashing that prevents cradle from spreading; D, hydraulic ram to start ship if necessary; E, wedges to take weight of ship; F, sliding ways; G, ground ways.

Photo by New York Shipbuilding Co.

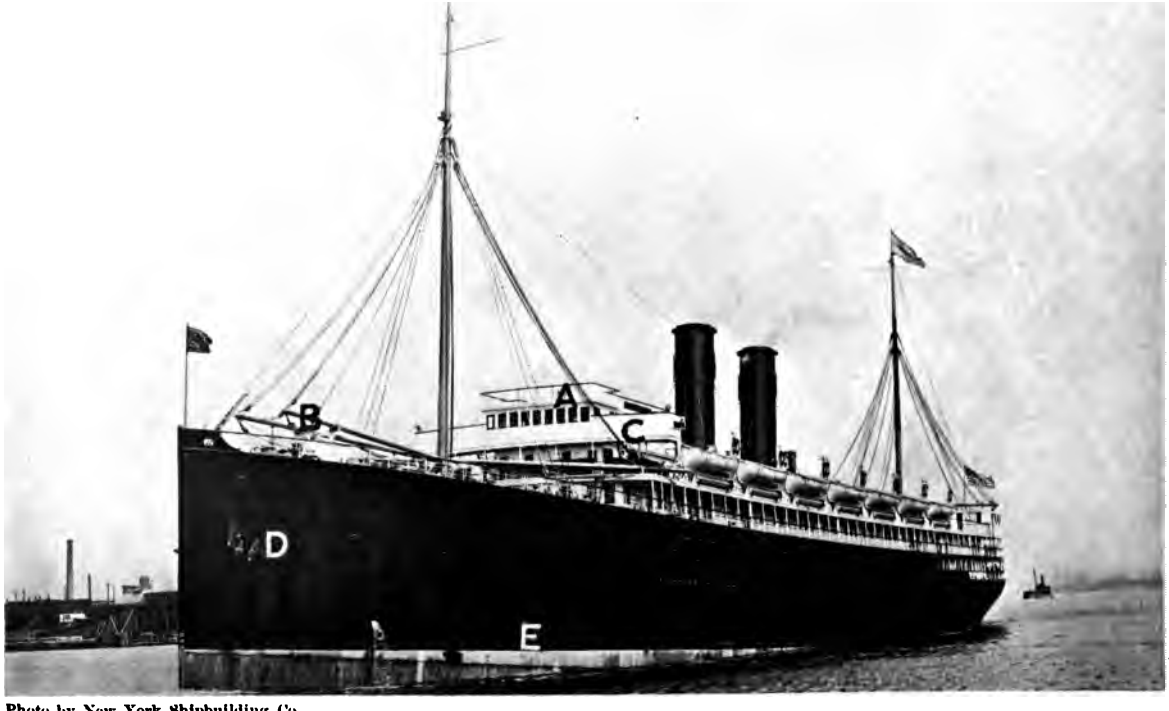



Photo by New York Shipbuilding Co.

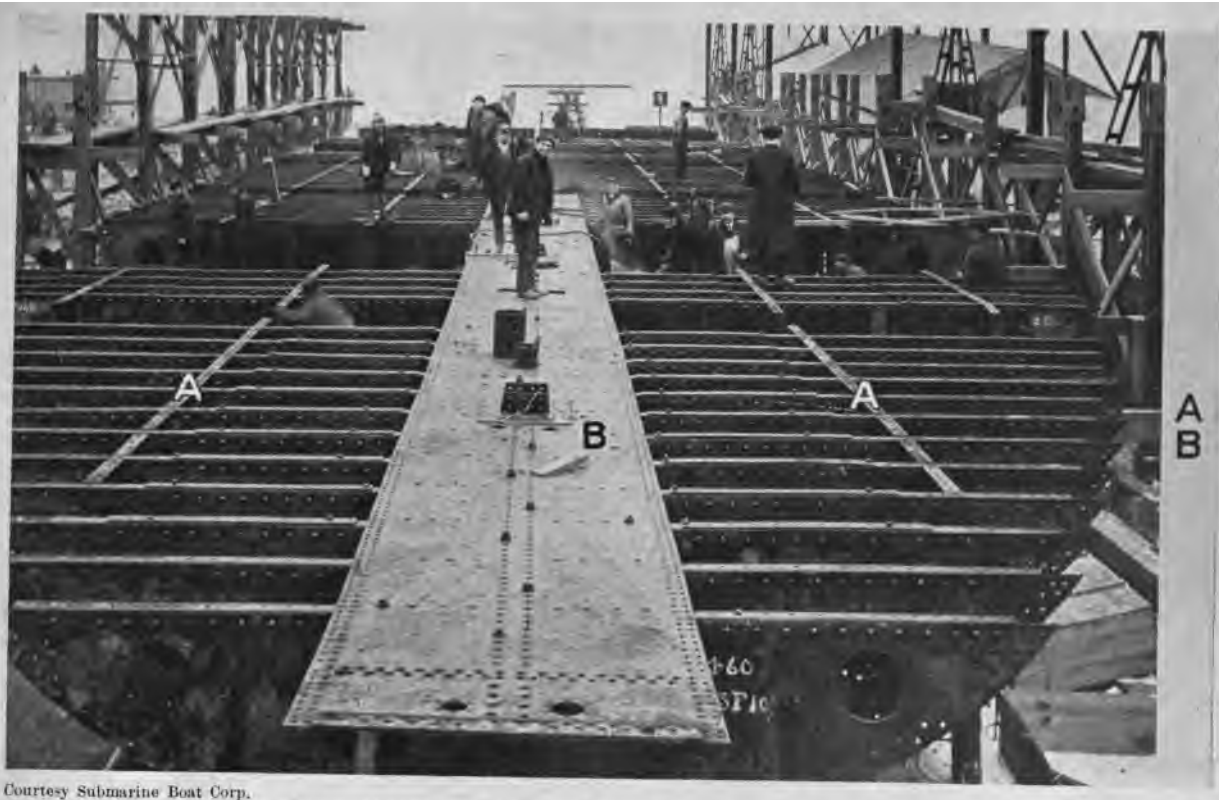
PLATE XVIII.—Ship ready for trial. A, pilot house; B, cargo booms; C, navigating bridge; D, anchor hove up to hawse pipe; E, waterline

Courtesy Submarine Boat Corp.

PLATE XIX.—The beginning of a "fabricated" ship. A, angle bars to secure tank top to keelson; B, clips to take floors; C, vertical keelson.

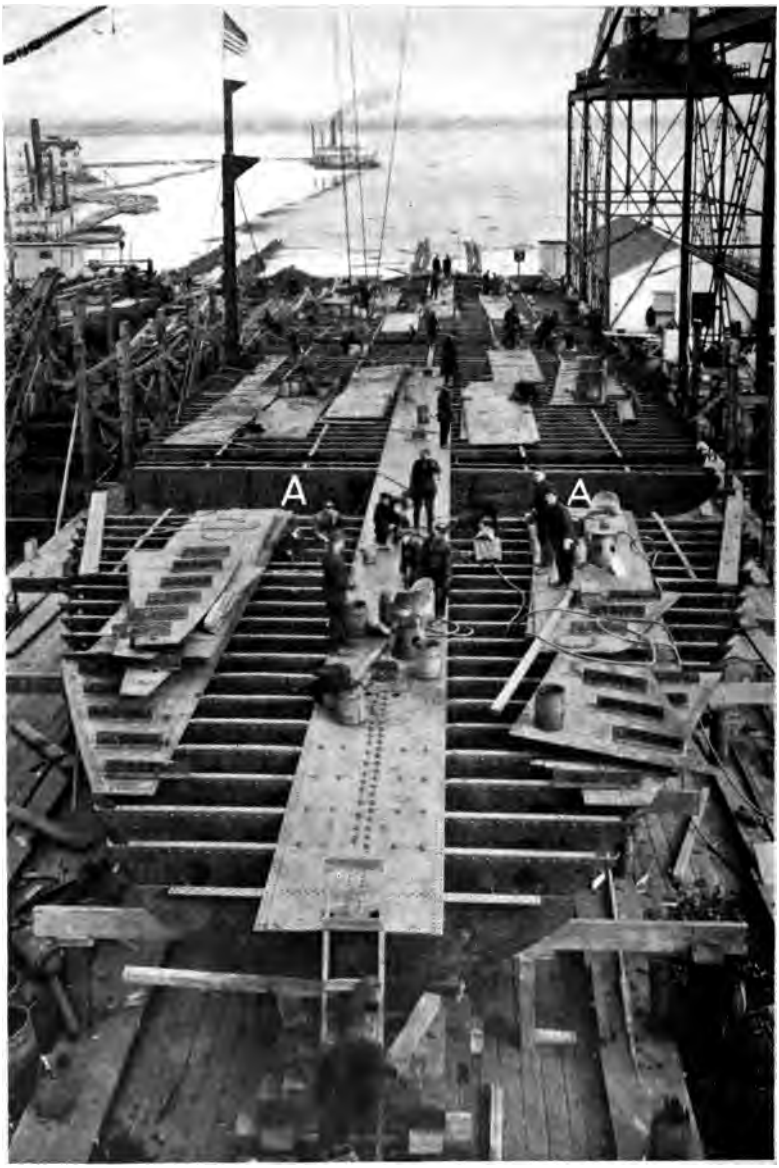
...n Boat Corp.

PLATE XX.—Showing construction of floors. A, floors; B, lightening hole.




Courtesy Submarine Boat Corp.

PLATE XXI.—Showing spacing of intercostals and other features of inner bottom framing. A, line of intercostals; B, center strake of tank top or inner bottom.




Courtesy Submarine Boat Corp.

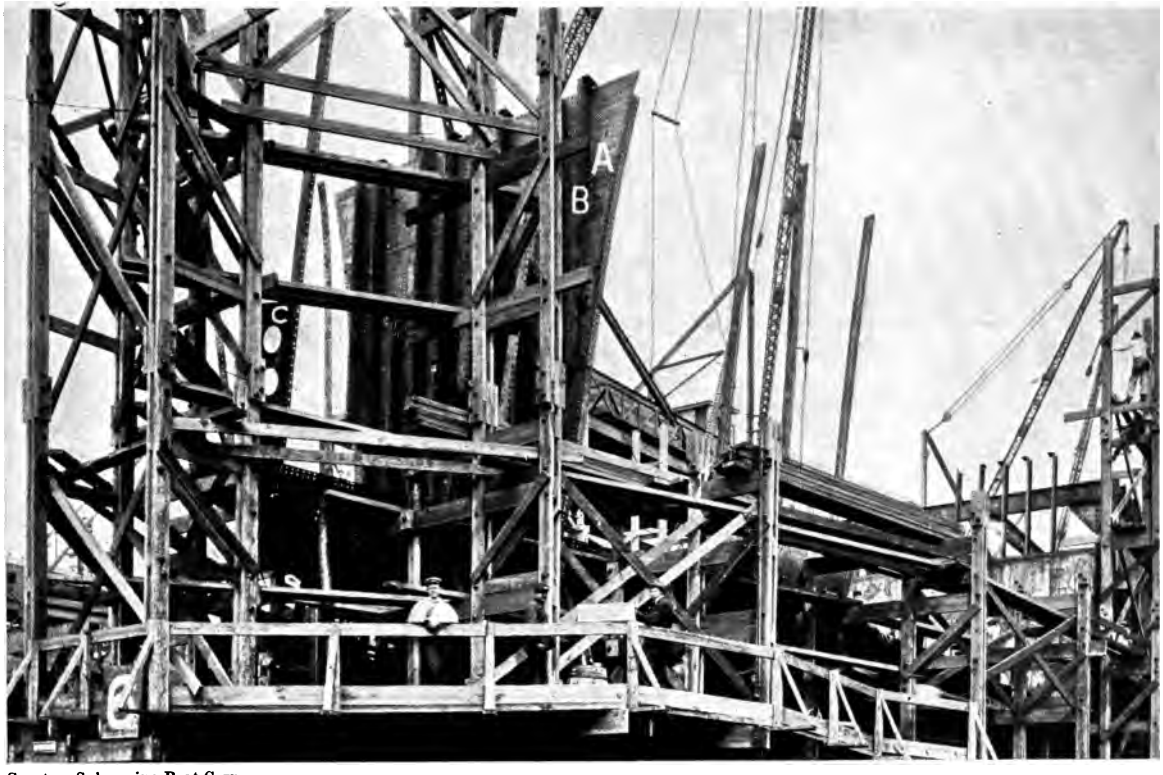
PLATE XXII.—Showing margin plates with bracket clips ready to be placed on floors. A, vertical clips to take intercostals.

Courtesy Submarine Boat Corp.

PLATE XXIII.—This picture shows beginning of fore-peak bulkhead and side framing. A, bounding angle bar; B, bolting up; C, holes for pipe flange for pump connections.

Courtesy Submarine Boat Corp.

PLATE XXIV.—View looking aft. A, after-peak bulkhead; B, side frames in after body; C, bracket plate flanged over.




Courtesy Submarine Boat Corp.

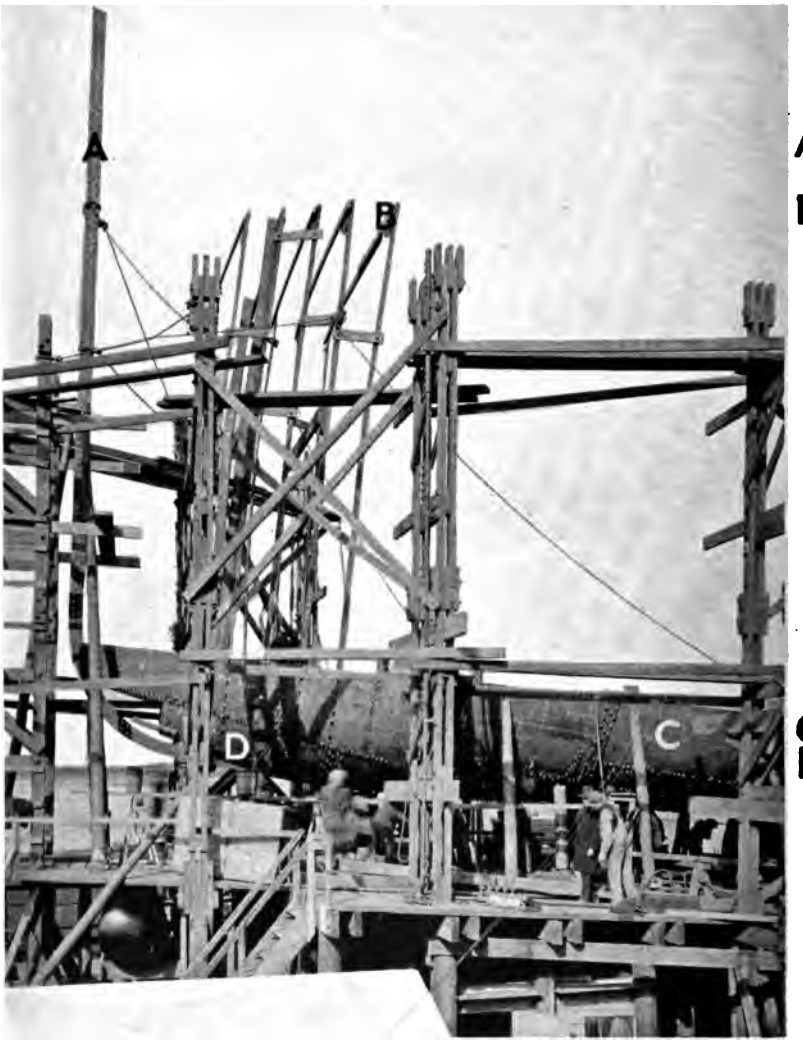
PLATE XXV.—A, fore-peak bulkhead; B, stiffener bars; C, floor plate in fore-peak. Such floors are called deep floors.

Courtesy Submarine Boat Corp.

PLATE XXVI.—Inside view of side frames. A, beam bracket; B, column or pillar; C, web frames.

Courtesy Submarine Boat Corp.

PLATE XXVII.—View of stern in process of construction. A, palm for connecting stern frame to floor plate and transom plate; B, arch piece; C, scarphs; D, propeller shaft boss; E, propeller post; F, keel; G, end of keel; H, sole piece.




Courtesy Submarine Boat Corp.

PLATE XXVIII.—A view of the bow in process of construction. A, stem; B, fore-peak frames; C and D, stealer plates.

Courtesy Submarine Boat Corp.

PLATE XXIX.—Forward view from ground. A, forward bulkhead; B, shell plating.

Courtesy Submarine Boat Corp.

PLATE XXX.—A bow view of first "fabricated" ship just previous to launching. A, apron; B, hawse pipe.

Courtesy Submarine Boat Corp.

PLATE XXXI.—A view of furnace room (in process of construction). A, furnace (incomplete); B, bending floors.

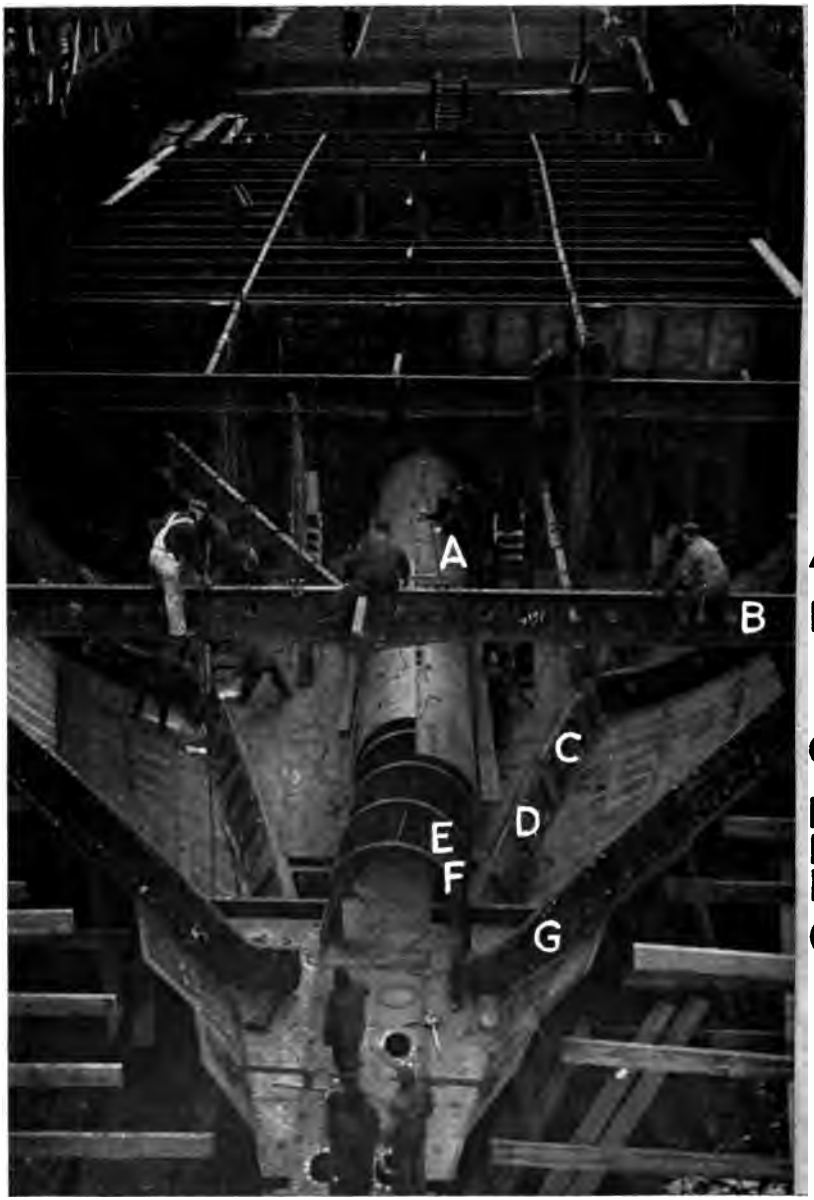
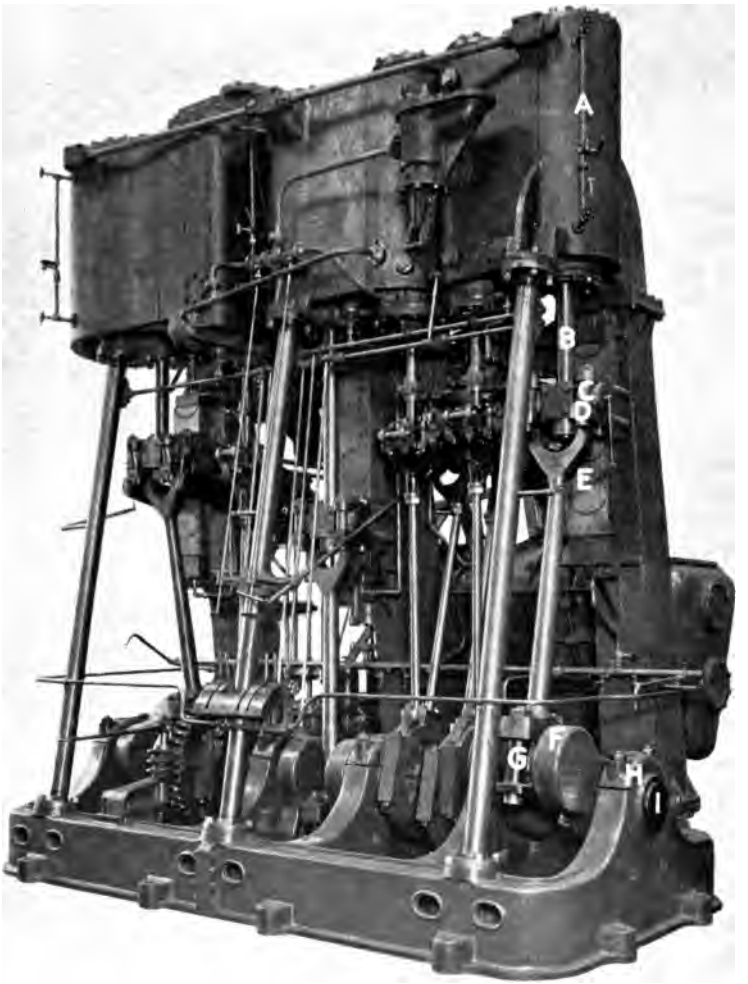



PLATE XXXII.—View to show construction of shaft alley. A, shaft tunnel or alley; B, deep beam to web frame; C, clips for bilge brackets; D, margin plate; E, stiffeners or frames for shaft alley; F, last few frames not fully in place; G, web frame.

Photo by New York Shipbuilding Co.

PLATE XXXIII.—Showing interior of pilot house. A, voice tube; B, whistle pull; C, telltale; D, engine telegraph.




Courtesy The Marine Engineer.

PLATE XXXIV.—A modern marine engine. A, indicator pipe; B, piston rod; C, crosshea gudgeon pin; D, connecting-rod top end brasses; E, indicator movement gear; F, crank wel G, connecting-rod bottom end brasses; H, main bearing; I, crankshaft.

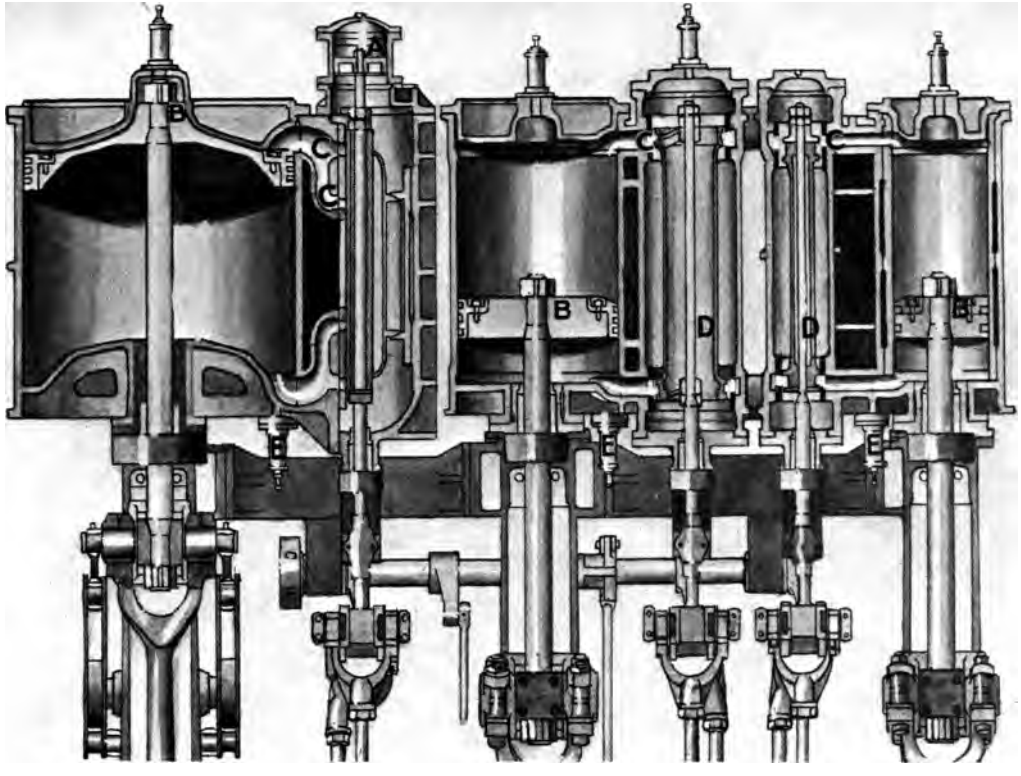



PLATE XXXIV-A.—Section through top half of engine shown in Plate XXXIV. A, balanced valve cylinder; B, piston heads; C, steam ports; D, piston valves; E, drain cocks.

Photo by Edwin Levick, N. Y.

PLATE XXXV.—Showing engine and thrust bearing. A, cylinder; B, piston; C, piston rod; D, cross-head; E, pump levers; F, engine crosshead; G, lever links; H, pump levers; I, thrust shaft; J, thrust bearing; K, thrust shaft; L, thrust bearing; M, engine crosshead.

Photo by Edwin Levick, N. Y.

PLATE XXXVI.—View of engine showing cast columns front and back. A, valve stem stuffing box; B, valve stem; C, valve stem guide bracket; D, weigh shaft; E, drag links; F, valve quadrant; G, cylinder drains control rod; H, eccentric rod; I, connecting rod; J, front and back column; K, eccentric strap; L, eccentric sheave; M, crankshaft.

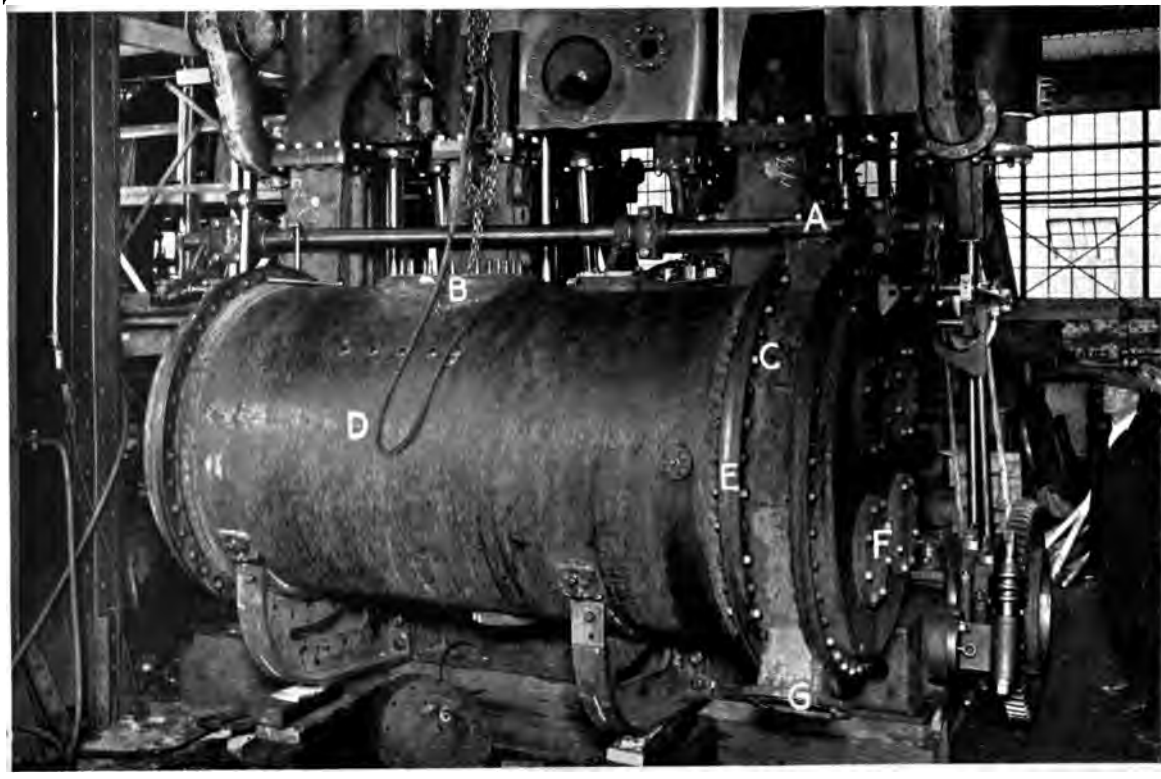



PLATE XXXVII.—Steam condenser for reciprocating engine. A, circulating water outlet; B, main exhaust steam inlet; C, condenser head; D, condenser; E, condenser tube plate; F, condenser door hand hole plate; G, circulating water inlet.

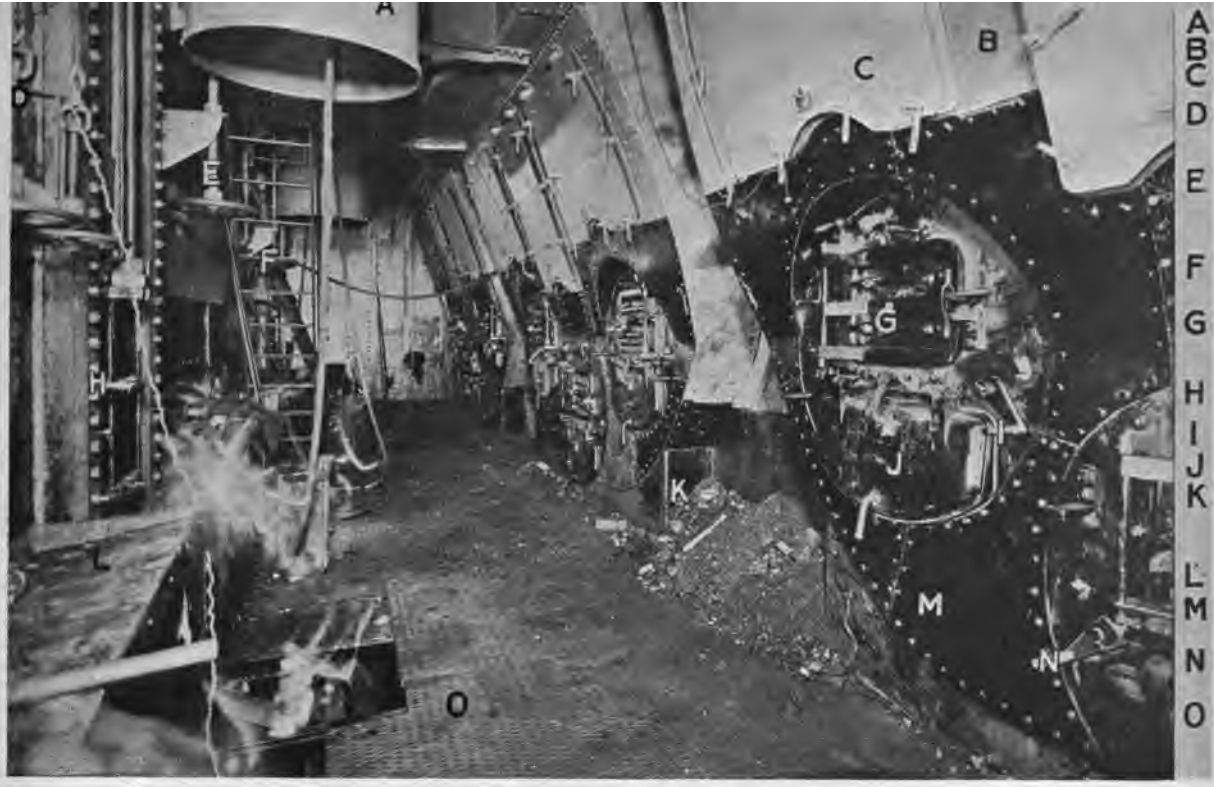



PLATE XXXVIII.—View of boiler room. A, ventilator; B, smoke box; C, smoke box door; D, safety valve casing gear; E, ventilator turning gear; F, stokehold ladder to fidley; G, furnace door; H, forward bulkhead watertight coal bunker door; I, air valve control lever; J, airtight ash pit door; K, fenders; L, casing about valves in bilge and tank pipes; M, lagging around boilers; N, air valve control lever; O, stokehold floor plates.

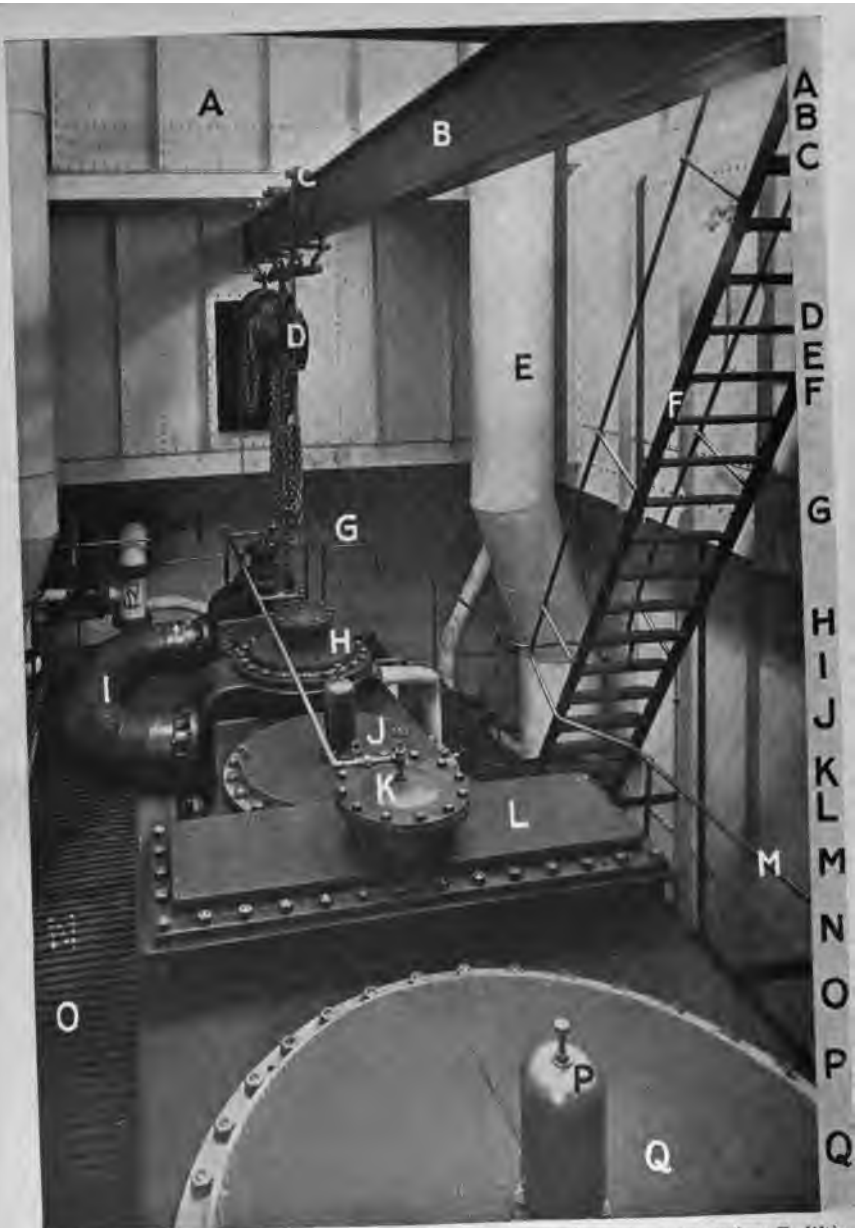
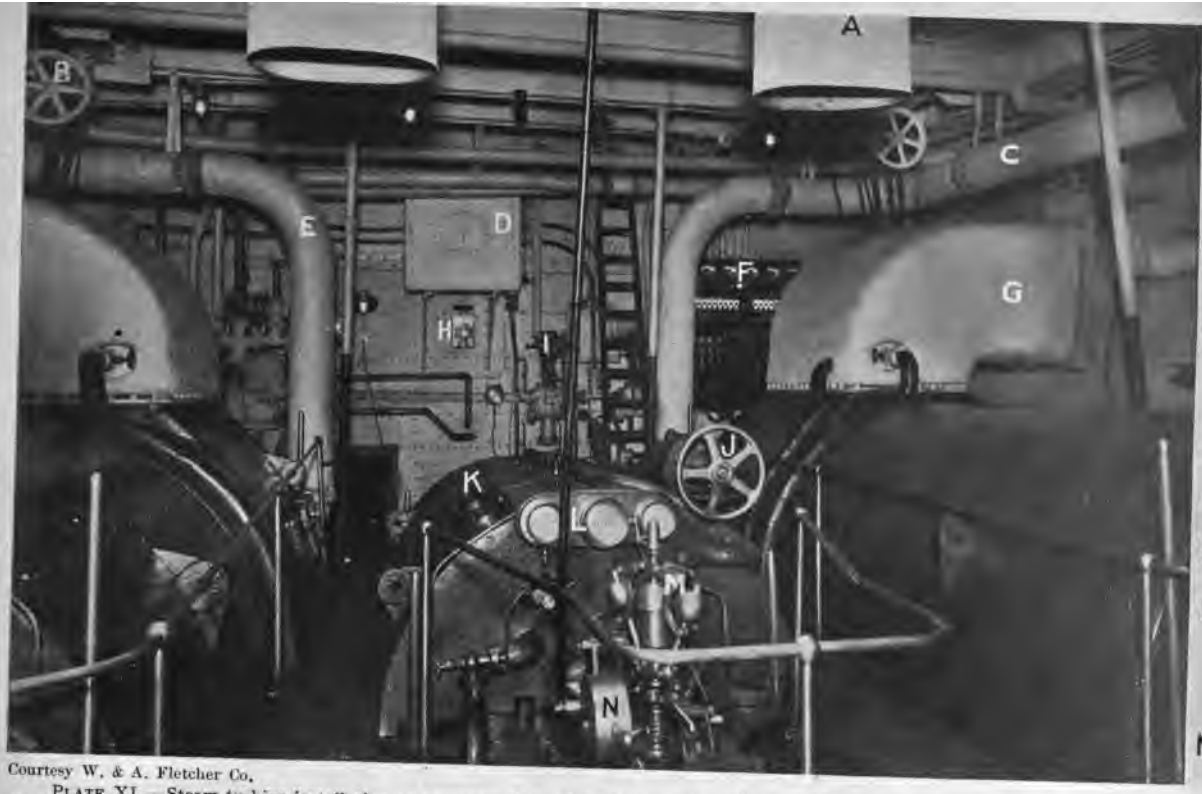
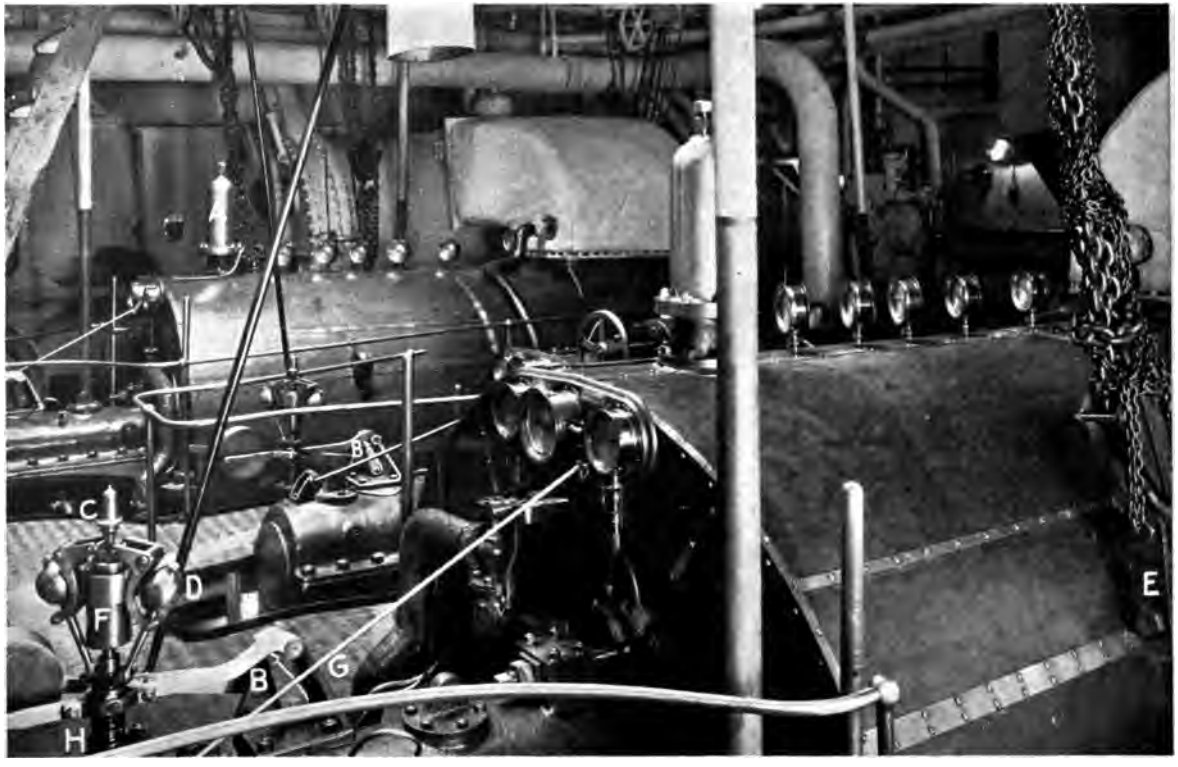



PLATE XXXIX.—View of upper part of engine room. A, engine room casing; B, lifting *gear* beam; C, lifting gear traveler; D, lifting gear; E, ventilator; F, engine room ladder; G, *forward end of engine room*; H, I. P. piston valve casing covering; I, steam pipe from H. P. to *I. P. valves*; J, *I. P. cylinder* covering; K, slide valve balance cylinder; L, L. P. slide valve casing *M, hand rails*; N, steam pipe from I. P. to L. P. cylinder (under grating); O, top grating; P, *valve dome*; Q, L. P. cylinder cover.



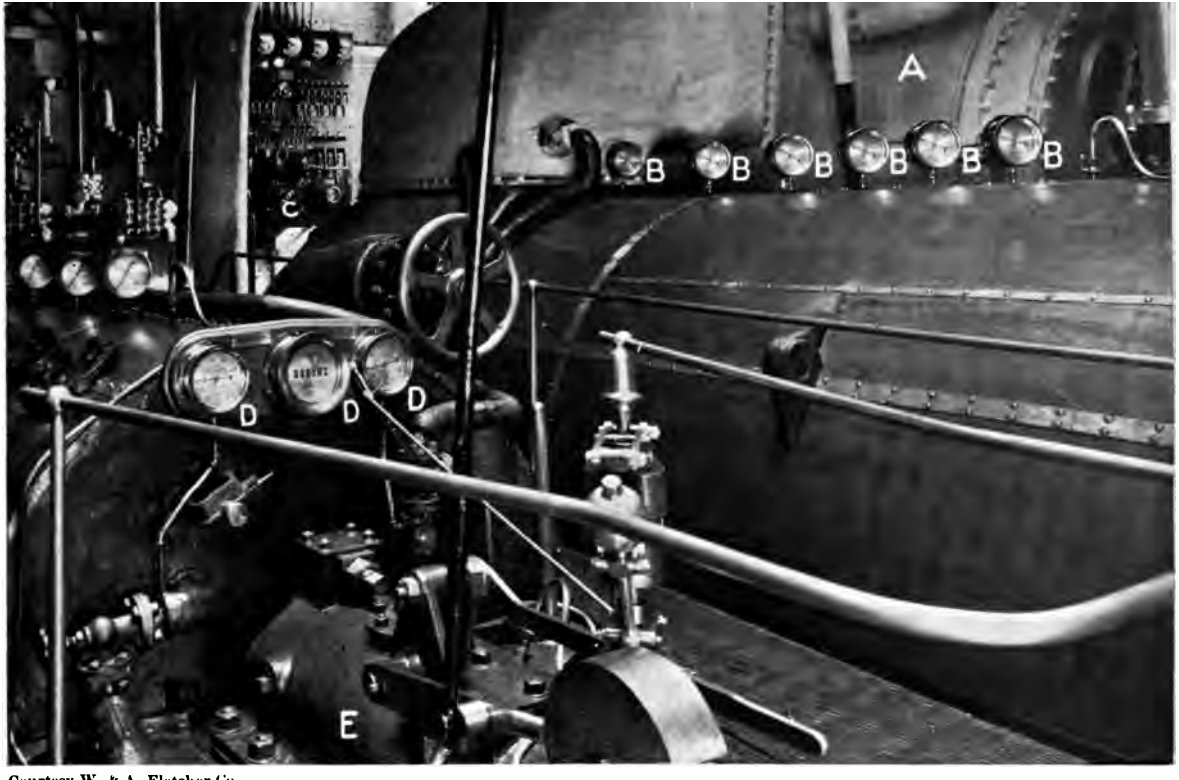

Courtesy W. & A. Fletcher Co.

PLATE XL.—Steam turbine installation on passenger ship. A, engine roof ventilator; B, chain falls; C, steam pipes; D, oil service tank; E, steam pipes; F, electric service board; G, exhaust lines to condensers; H, bulkhead lamp; I, oil service pumps; J, throttle wheel; K, high-pressure turbine; L, revolution counter or tabulator; M, governor; N, governor safety weights.



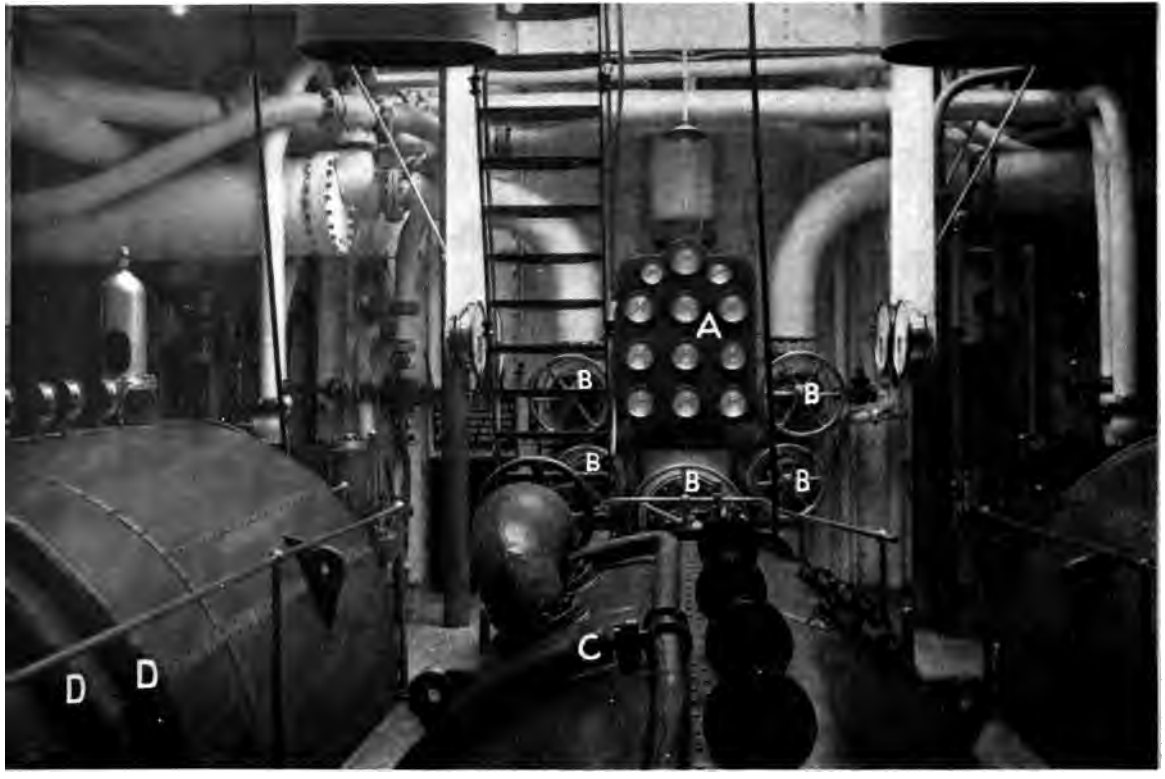

Courtesy W. & A. Fletcher Co.

PLATE XLI.—Another view of same engine room as Plate XL. A, safety valve on primary stage; B, engaging latch to safety stop on governor; C, governor regulator; D, ball weights on governor; E, chain fall and gear for lifting top half of casing; F, governor; G, connecting rods to revolution counter; H, revolution counter worm.




Courtesy W. & A. Fletcher Co.

PLATE XLII.—Another view of engine room shown in Plates XL and XLI. A, low-pressure turbine condenser; B, stage pressure gauges; C, electrical switchboard; D, operation control gauges and revolution indicator dial; E, main bearing inlet end.




Courtesy W. & A. Fletcher Co.

PLATE XLIII.—View of same engine room as in Plates XL, XLI and XLII. A, main gauge board; B, main controlling valves; C, main steam line seals; D, exhaust lines from seals.

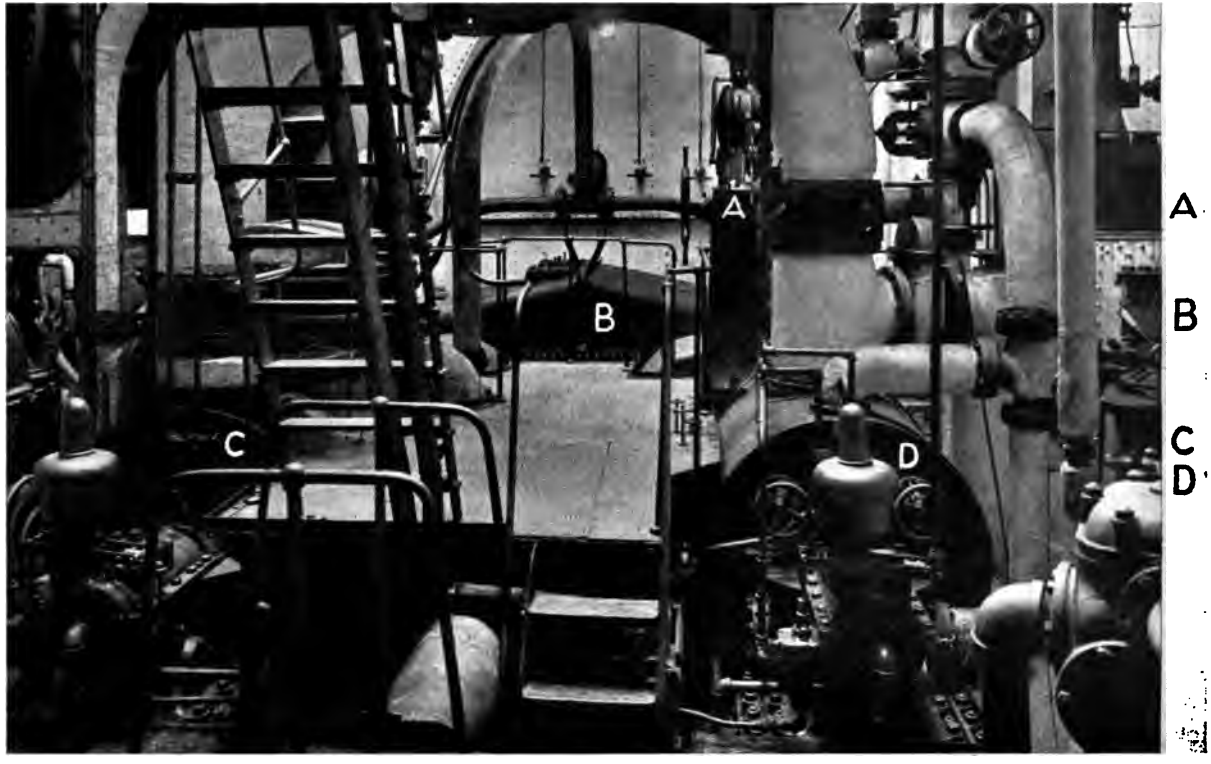



PLATE XLIV.—Westinghouse turbine installation on oil tanker. A, control station; B, reduction gear; C, L. P. turbine; D, H. P. turbine.

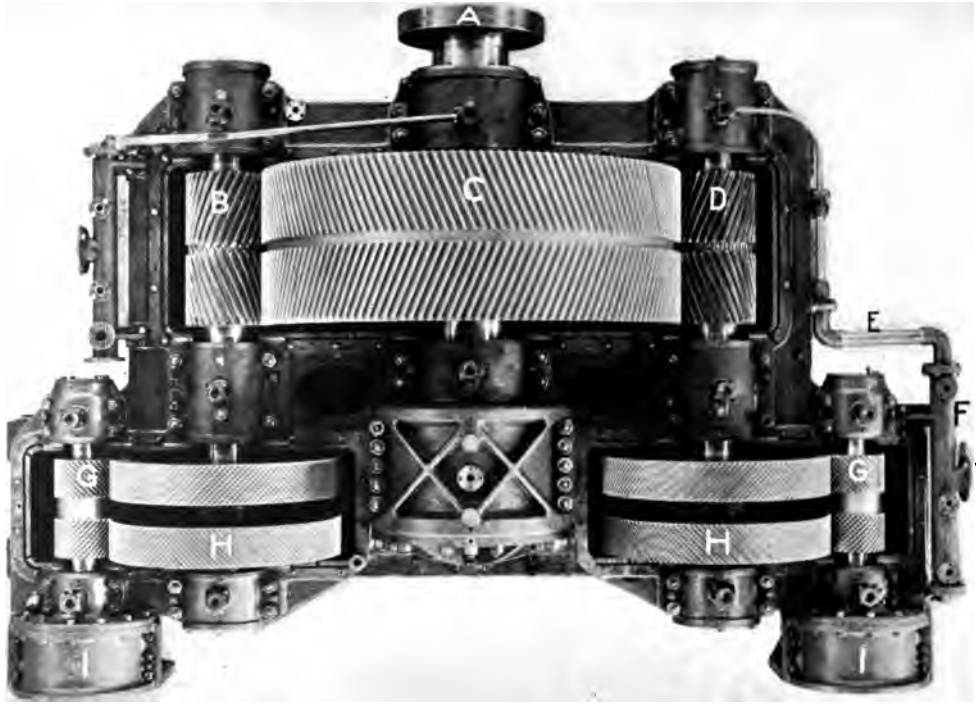



PLATE XLV.—A gear that reduces a turbine speed of 3600 R. P. M. to a propeller speed of 90 R. P. M. A, coupling to line shaft, *i.e.* propeller shaft; B, intermediate drive pinion; C, main gear; D, intermediate drive pinion; E, oil line; F, oil manifold; G, turbine shaft pinions; H, intermediate gears; I, connections to turbines.

PLATE XLVI.—A "burner," that is, one who operates a cutting torch. A, bending rolls; B, oxy-hydrogen torch cutting.

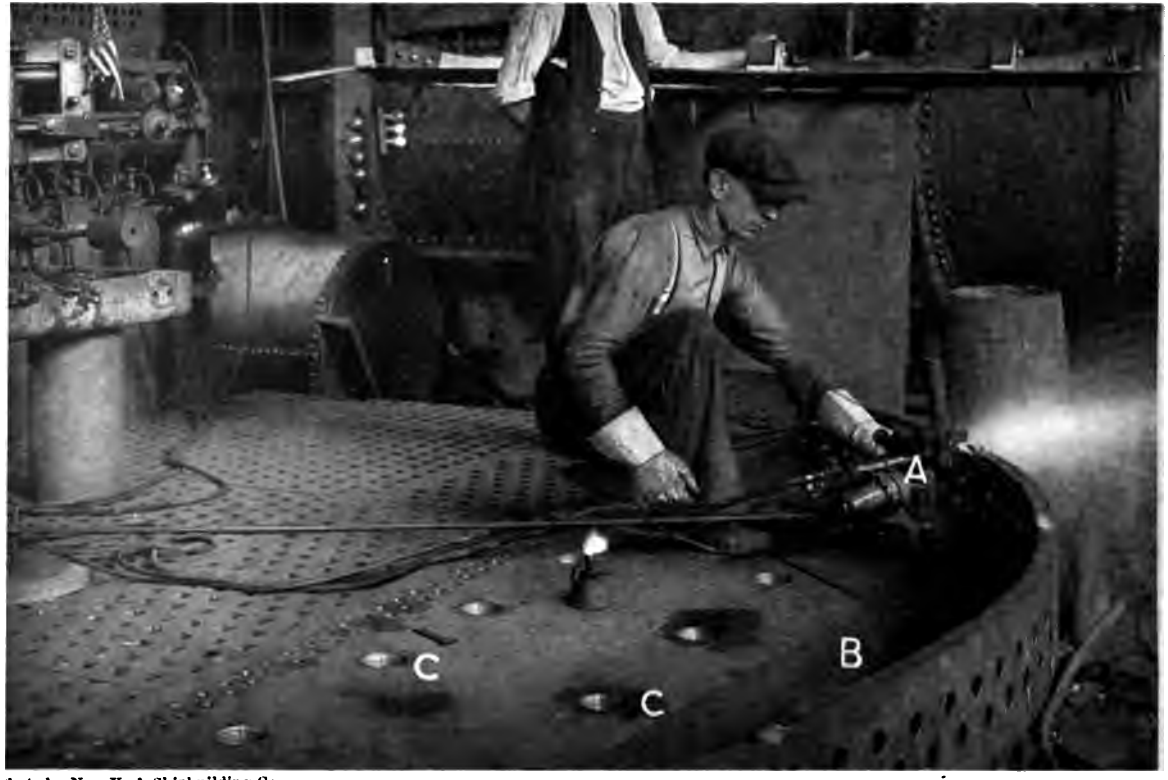



Photo by New York Shipbuilding Co.

PLATE XLVII.—Trimming a boiler head. A, oxy-acetylene cutting torch; B, top plate of boiler head; C, holes for stay rods.

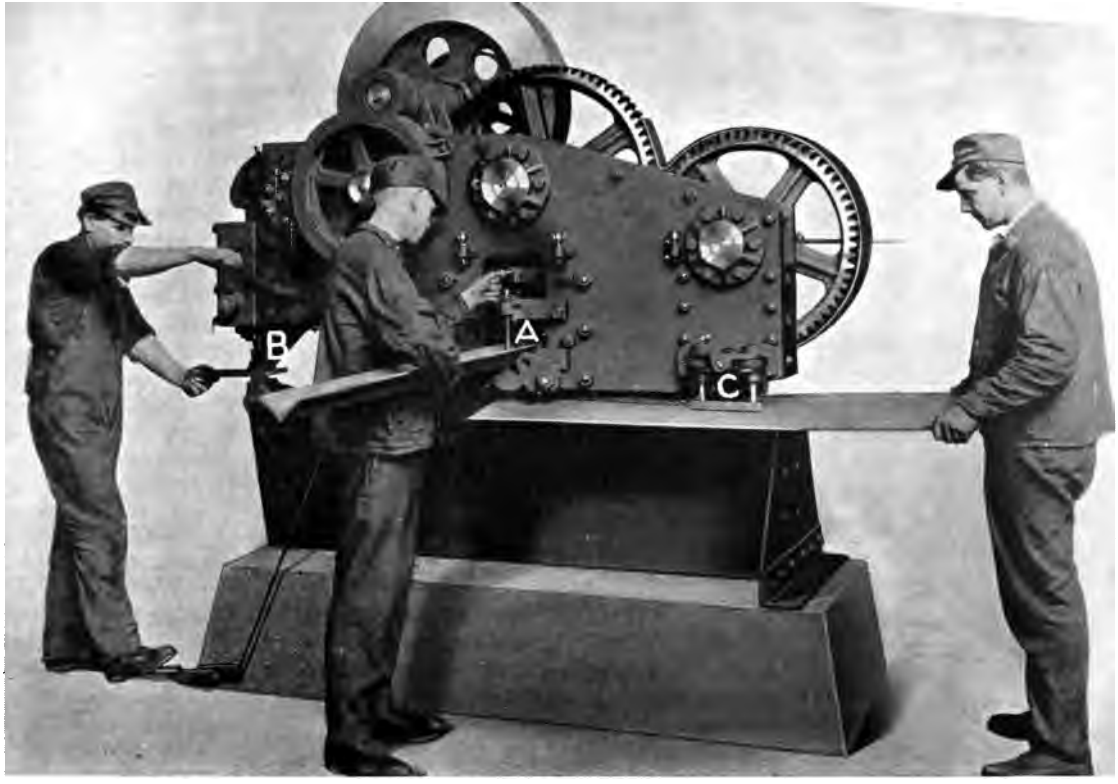



PLATE XLVIII.—Illustrating work done in a "fabricating" shop. A, cutting off angle bar; B, punching holes in plate; C, cutting or shearing plate.

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PLATE XLIX.—Illustrating operations in the yard. A, air reamer in operation; B, air caulking hammer in operation; C, steel mast.

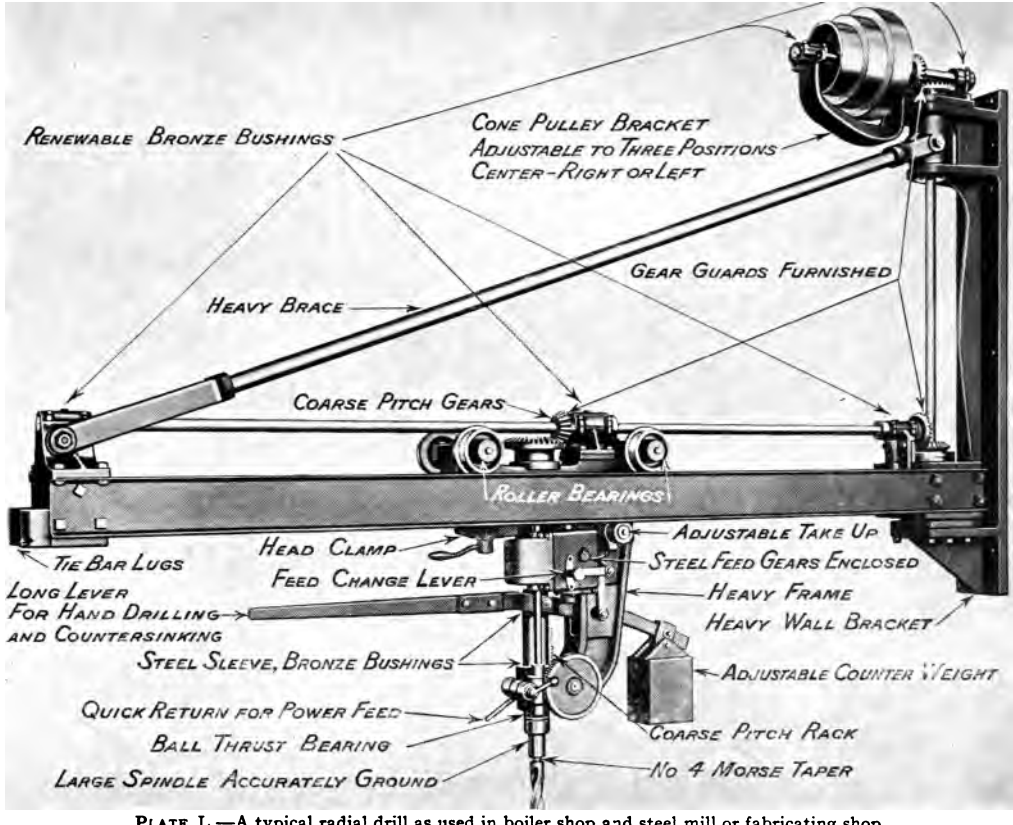



PLATE L.—A typical radial drill as used in boiler shop and steel mill or fabricating shop.

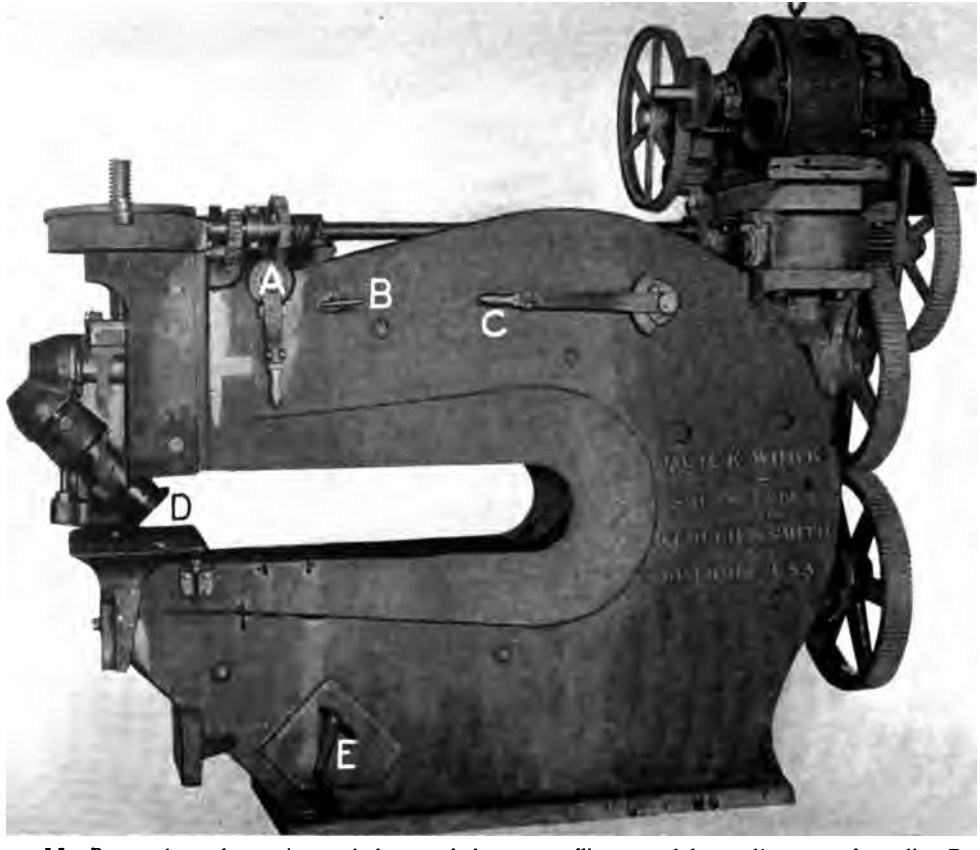



PLATE LI.—Rotary shears for cutting steel plates. A, lever controlling up-and-down adjustment of top disc; B, speed control handle of top disc; C, lever controlling speed of lower disc; D, disc cutter; E, crank operating sidewise adjustment of lower cutter.

PLATE LII.—Mold loft. Here lines of a ship are laid down full size and wood or paper templates are made by "loftsmen." A, making templates; B, laying down lines on floor.

FIG. 1.

FIG. 2.

*PLATE LIII.—Fig. 1*—This expert chipper is cutting a $\frac{5}{8}$-inch-thick tube plate. **A, air chipping machine.** *Fig. 2*—An instructor at the Newburgh shipyard training a learner to caulk a seam. **A, air caulking machine.**

FIG. 1.

FIG. 2.

PLATE LIV.—Fig. 1—Drilling holes in tank top with air drill. A, stick for bearing down on drill; B, air drill. Fig. 2—Reaming holes on side of ship with air reamer. A, reaming machine.

FIG. 1

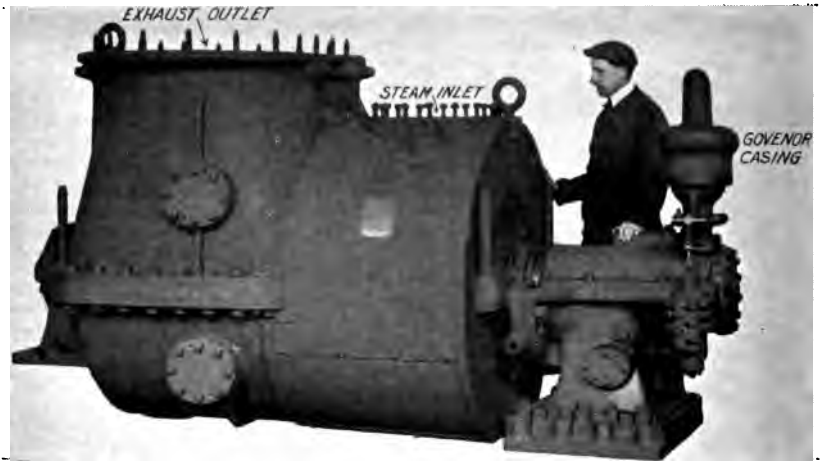



FIG. 2

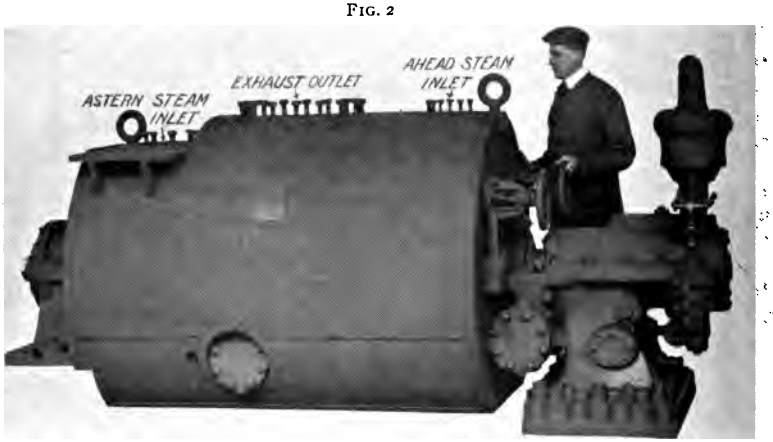
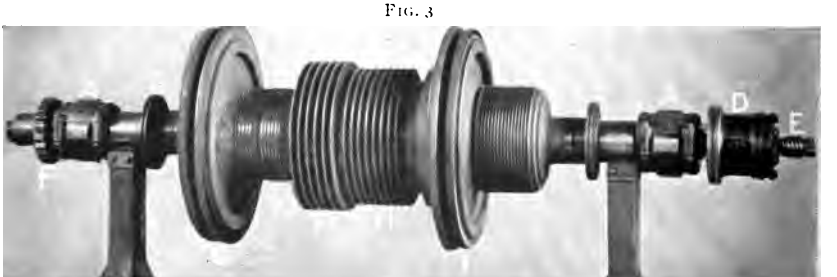



FIG. 3




*Courtesy Westinghouse Elec. & Mfg. Co.*

PLATE LIV-A.—*Fig.* 1, Westinghouse L. P. turbine. Fig. 2, Westinghouse H. P. turbine. *Fig.* 3, rotator for H. P. turbine (Westinghouse). A, main bearings; B, water gland runner; C, dummy rings; D, Kingsbury thrust bearing; E, worm for driving governor; F, ratchet gear for turning over; G, impulse blading astern; H, reaction blading ahead; I, impulse blading ahead.

FIG. 1.

FIG. 2.

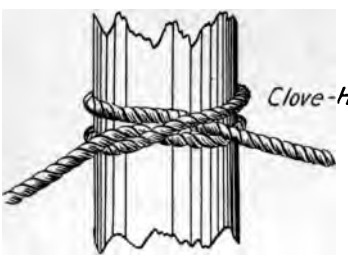
PLATE LV.—Fig. 1—Driving flush rivets in tank top. A, air riveting hammer. Fig. 2—*Driving snap rivets in floors.* A, air riveting hammer; B, air dollybar.

Square-Knot

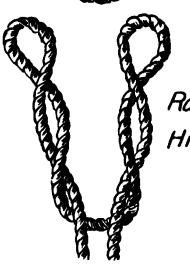
Granny-Knot

Sheet-Bend

Bowline on a Bight

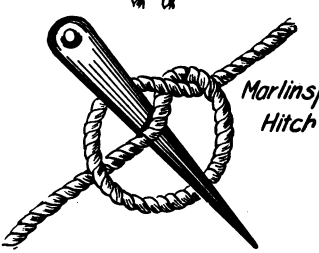


Clove-Hitch



Racking-Hitch

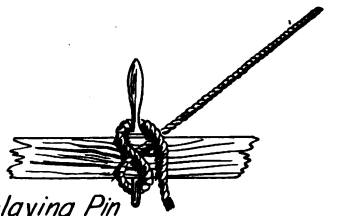
Blackwall-Hitch



Marlinspike-Hitch

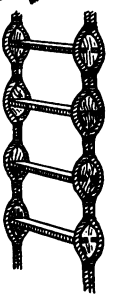
PLATE LVI

Method of securing block to hawser with strap

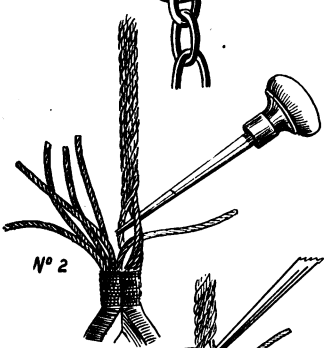


Belaying Pin

Mousing on hook

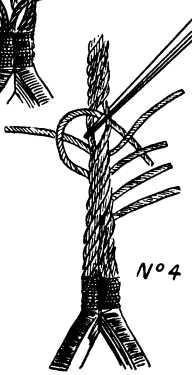


Jacobs Ladder



N° 2

N° 3



N° 4

Eye splice in wire

N° 1

PLATE LVII

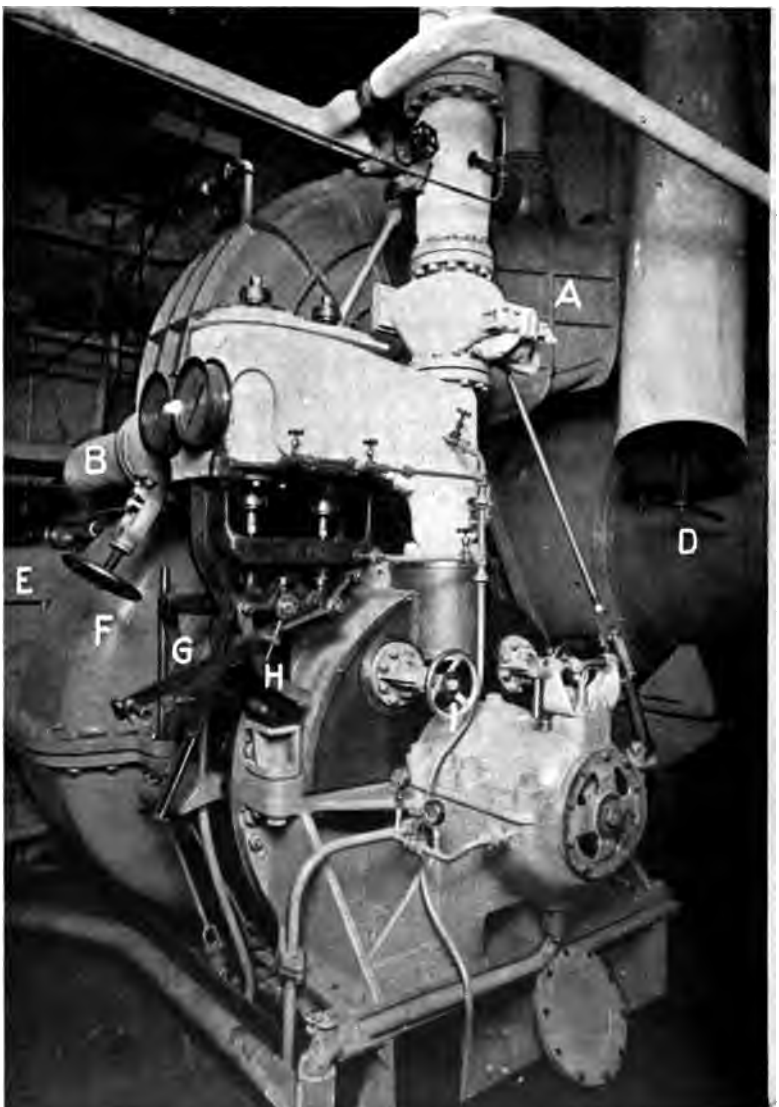



PLATE LVIII.—A General Electric Company turbine installation on a cargo ship. **A**, *connection* to condenser; B, astern steam inlet; C, ahead steam inlet; D, condenser; **E**, *reduction gear casing; F, exhaust chamber*; G, manœuvring valve astern; H, manœuvring valve ahead; *I, hand valve.*

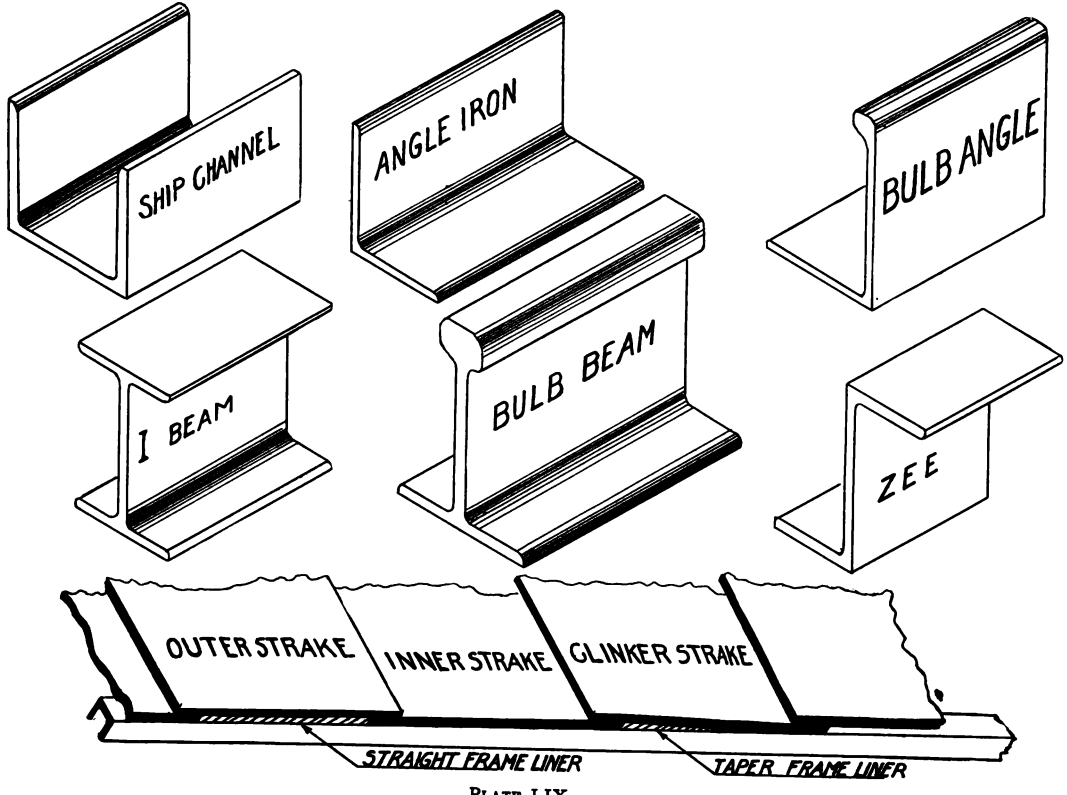
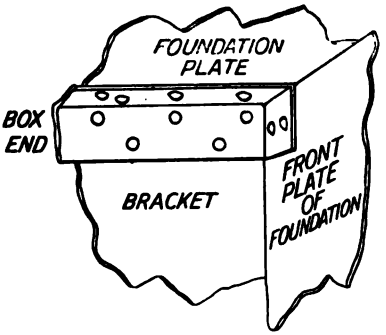
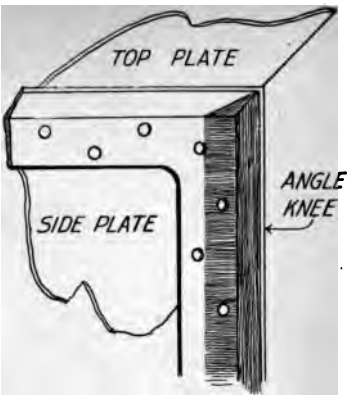
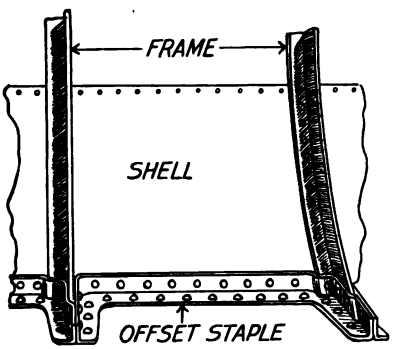
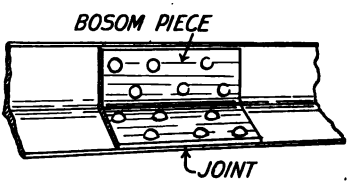

SHIP CHANNEL
ANGLE IRON
BULB ANGLE
I BEAM
BULB BEAM
ZEE
OUTER STRAKE
INNER STRAKE
CLINKER STRAKE
STRAIGHT FRAME LINER
TAPER FRAME LINER

PLATE LIX


FOUNDATION PLATE
BOX END
BRACKET
FRONT PLATE OF FOUNDATION


TOP PLATE
ANGLE KNEE
SIDE PLATE


FRAME
SHELL
OFFSET STAPLE


BOSOM PIECE
JOINT

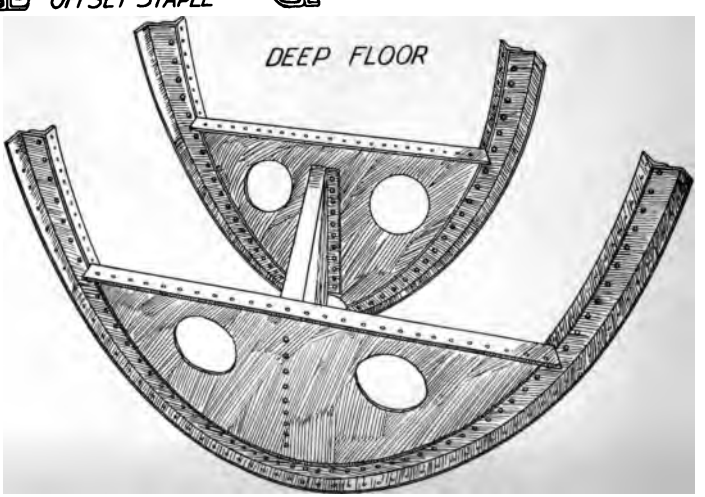

DEEP FLOOR

PLATE LX

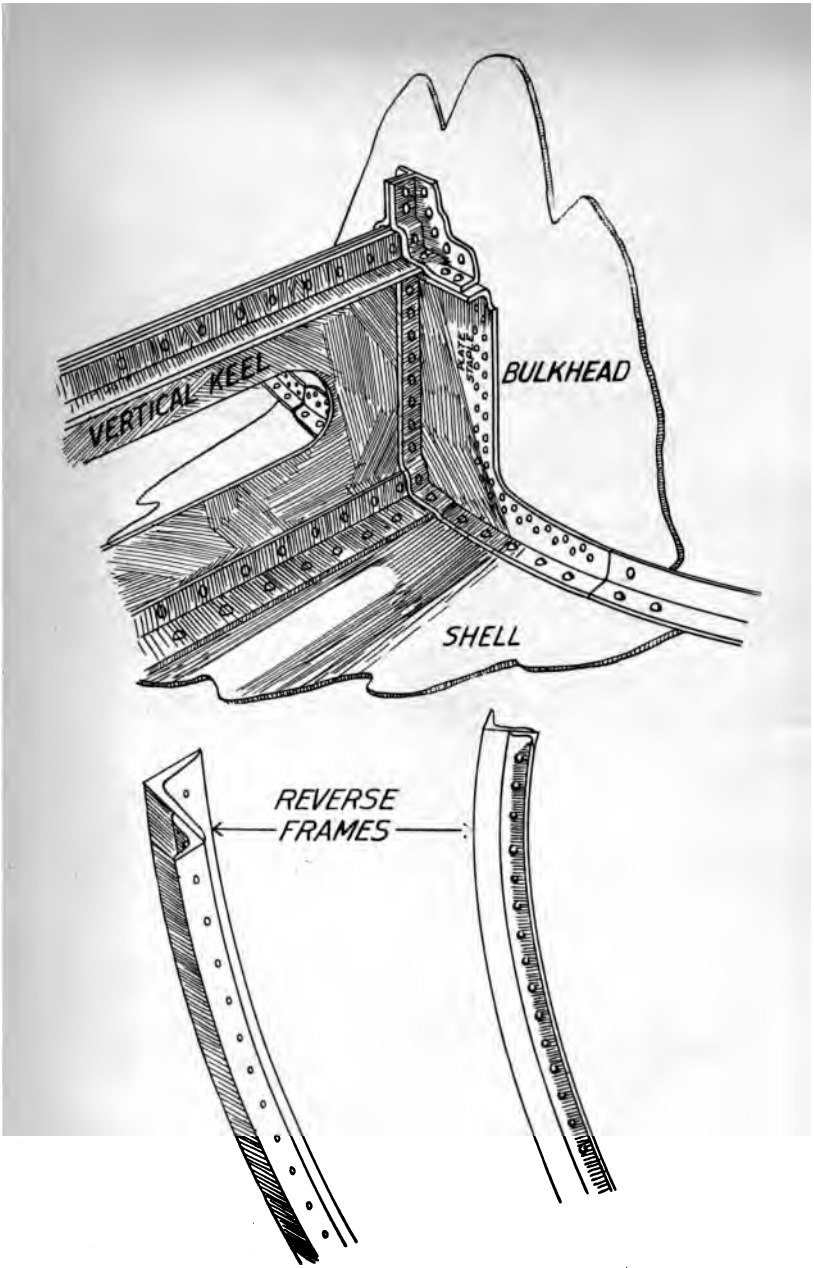
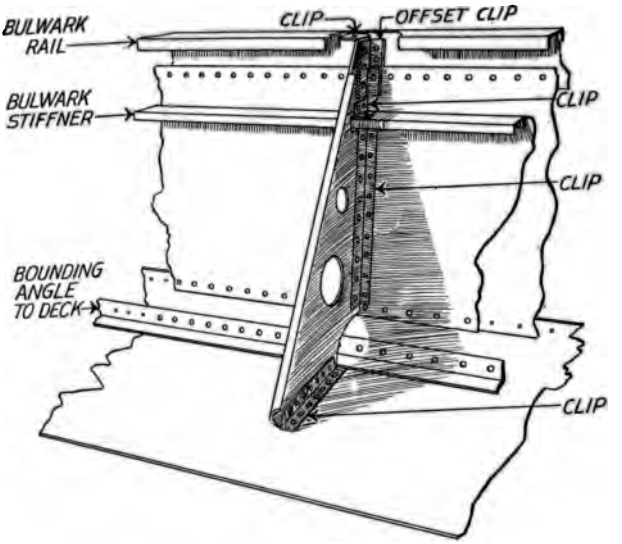



PLATE LXI


BULWARK RAIL
CLIP
OFFSET CLIP
BULWARK STIFFNER
CLIP
CLIP
BOUNDING ANGLE TO DECK
CLIP

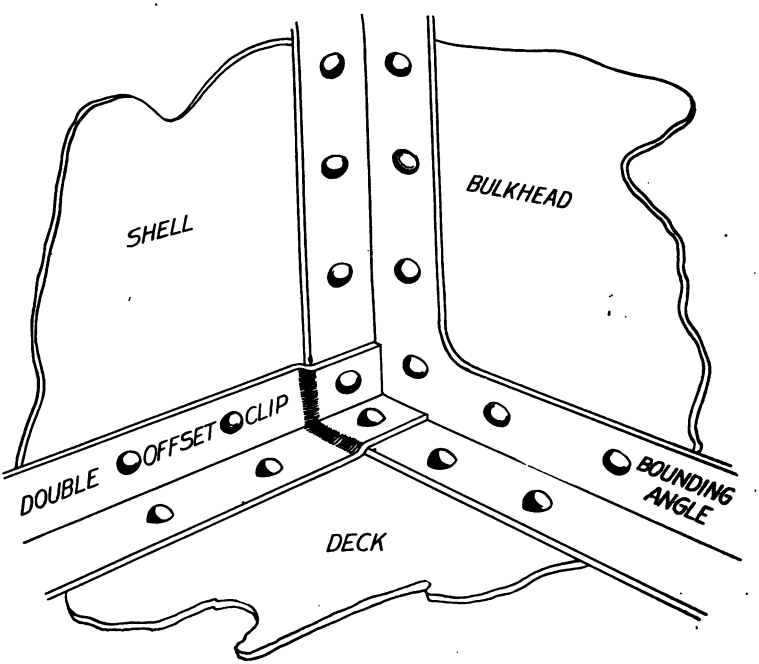

SHELL
BULKHEAD
DOUBLE
OFFSET CLIP
BOUNDING ANGLE
DECK

PLATE LXII

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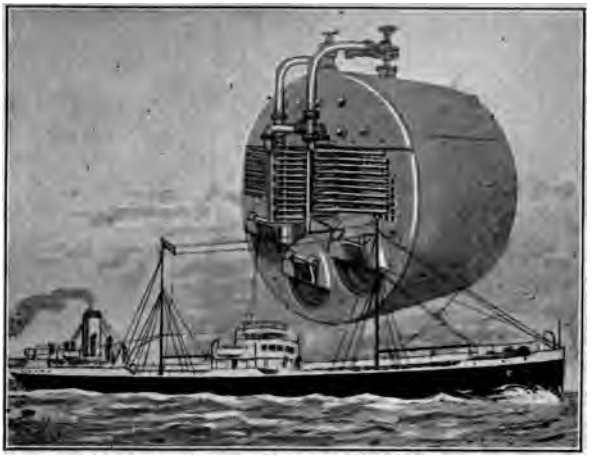

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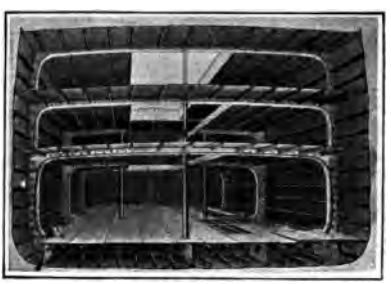

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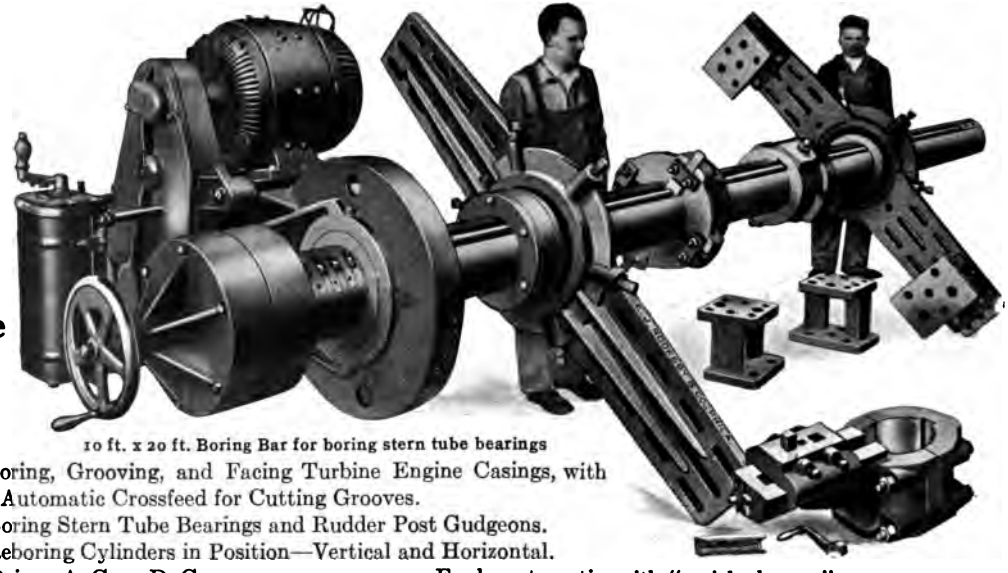

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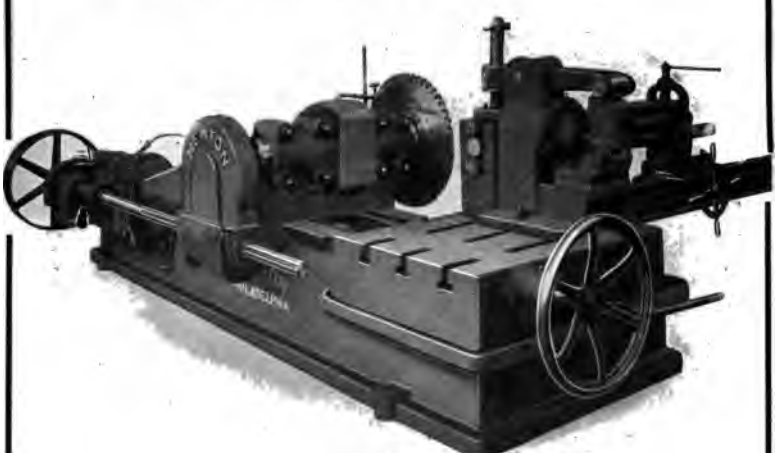

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